AD-A221 412

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N-25-82-22

AIR CUSHION VEHICLE OPERATOR TRAINING SYSTEM (ACVOTS) SIMULATOR REQUIREMENTS ANALYSIS

VOLUME I OF II

JUNE 1982

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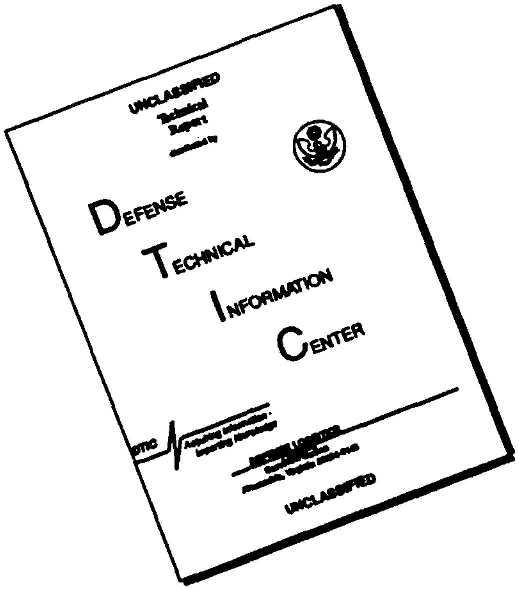

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) Air Cushion Vehicle Operator Training System (ACVOTS) Simulator Requirements Analysis	5. TYPE OF REPORT & PERIOD COVERED Final Report Volume I of II
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Hostetter, Wayne K.; Keegan, John B.; Baker, Robert M.; Rossi, Anita M.	8. CONTRACT OR GRANT NUMBER(s) N61339-80-D-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS Allen Corporation of America, 401 Wythe Street, Alexandria, Virginia 22314	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Training Equipment Center, Code N-252, Orlando, FLorida 32813	12. REPORT DATE June, 1982
	13. NUMBER OF PAGES 65
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) David Taylor Naval Ship Research and Development Center, Code 1180, Bethesda, Maryland 20014	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

~~Procurement Sensitive: NOT Releasable Outside DOD Without Written Permission of the Naval Training Equipment Center.~~

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Air Cushion Vehicle Operator Training System (ACVOTS)
Landing Craft, Air Cushion (LCAC)
Instructional Systems Development (ISD)
Training Devices
Surface Craft
Operator Training
Criterion Objectives

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents the results of an Air Cushion Vehicle Operator Training System (ACVOTS) Simulator Requirements Analysis. Data were collected from ACV training and surface ship simulation site visits. The focus of the analysis was on ACVOTS training device requirements with emphasis on the LCAC long-term operator training system.

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S/N 0102-LF-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract (cont'd.)

The analysis consisted of a series of process steps as outlined in a draft military specification, Procedures for Simulator Requirements Analysis, MIL-T-XXXXX. The basis for all training requirements used was the experimental JEFF(B) ACV undergoing RDT&E at the Amphibious Assault Landing Craft (AALC) Experimental Trials Unit (ETU). Analysis steps included:

- Problem Analysis Report (PAR) review,
- Training Development and Support Plan review,
- Training Equipment Survey,
- Task Listing development,
- Training Device Tasks,
- Candidate Training Devices,
- Task Assignments,
- Trainer Functional Descriptions,
- Assessment of Candidate Training Devices, and
- Recommended and Alternative Training Devices.

Training requirements analysis for 7 candidate training devices and mixes thereof indicated that the most training and cost effective approach to a totally integrated academic, simulation and actual craft training approach included the following training devices:

- Cockpit Procedures Trainer,
- Limited Visual Field-of-View Part-Task Trainer, and
- Full Mission Trainer (Operator, Engineer and Navigator).

This device mix resulted in a cost ratio of nearly 6 to 1 over a craft-alone approach. A final decision regarding simulation in the long-term LCAC training system will result in the initiation of the procurement cycle. A two phase implementation may be necessary due to potential slippages in procurement of the FMT.

EXECUTIVE SUMMARY

This Air Cushion Vehicle Operator Training System (ACVOTS) Simulator Requirements Analysis was conducted at the direction of the David Taylor Naval Ship Research and Development Center to define the role of simulation in Air Cushion Vehicle (ACV) operator training and to make recommendations concerning potential training devices for the ACVOTS program.

Two advanced development ACVs, designated JEFF(A) and JEFF(B), are currently being tested under the Navy's Amphibious Assault Landing Craft (AALC) program. Focus in this analysis was on the JEFF(B) at the AALC Experimental Trials Unit (ETU) due to its projected similaritites with the Landing Craft, Air Cushion (LCAC), the first Navy fleet ACV.

Recommendations for ACVOTS long-term LCAC operator training program training device procurement were developed as a result of a detailed hands-on training requirements analysis. A draft military specification, Procedures for Simulator Requirements Analysis, MIL-T-XXXXX, was used as a guide in performance of this analysis. Although recommendations contained herein should be implemented prior to and during the short and mid-term LCAC training program, they affect only the long-term program, beginning with LCAC follow-on training. The recommended suite of training devices for the long-term LCAC operator training program includes the following trainers:

- Cockpit Procedures Trainer (CPT): a fixed base full replication of the LCAC control cabin operator and engineer stations. All primary and secondary controls as well as mission-critical systems management controls and indicators (gauges, lights, etc.) are duplicated and interact in a semi-dynamic manner; the device is to be used for initial procedures training and complex psychomotor task procedures familiarization;

- Complex Part-Task Trainer (PTT2): a fixed base partial replication of the LCAC control cabin operator and engineer stations. All primary and secondary controls and monitoring instruments are duplicated and interact in a dynamic manner; a limited field-of-view (FOV) visual display is driven by a craft math model and operator/engineer inputs; the device is to be used for initial complex psychomotor task performance training.

- Full Mission Trainer (FMT): a motion base full replication of the LCAC control cabin operator, engineer and navigator stations. All primary and secondary controls as well as mission-critical systems management

controls and indicators (gauges, lights, etc.) are duplicated and interact in a dynamic manner; a nearly full FOV visual system and the motion base are driven by a craft math model and crew inputs; with the ability to simulate some task exercises not possible on the actual craft, the FMT will provide full mission team capability and full performance qualification of many tasks prior to LCAC underway training.

This suite of trainers demonstrated the most training impact on LCAC utilization in training and the lowest overall operating cost over the system's life cycle. In addition, the progression of learning inherent in this suite was judged most suitable to ensure adequate trainee preparation for actual craft operation under fleet training site constraints of congestion, noise and safety.

Alternative devices considered included a Cockpit Familiarization Trainer (CFT - a non-dynamic operator and engineer station mock-up), an Operational Underway Trainer (OUT - the FMT without the navigator's station) and two panel mock-ups (PTT1-A and PTT1-B - the main circuit breaker panel and the fuel management panel). Artists' impressions of all these devices are shown in Volume II, Appendix D. Analysis results indicated that the next most training and cost effective training device mixes were permutations of the three-device approach including:

	- CPT	Cockpit Procedures Trainer
Alternative Mix #1	- PTT2	Complex Part-task Trainer
	- OUT	Operational Underway Trainer
	- CFT	Cockpit Familiarization Trainer
Alternative Mix #2	- PTT2	Complex Part-task Trainer
	- FMT	Full Mission Trainer
	- CFT	Cockpit Familiarization Trainer
Alternative Mix #3	- PTT2	Complex Part-task Trainer
	- OUT	Operational Underway Trainer

The low utilization/relative high cost of the two panel mock-ups and the inclusion of the fuel management panel in both the CPT and FMT indicated they be removed from further consideration.

The advantages of the recommended mix as outlined above include:

- lowest mix procurement and operating costs for training system life-cycle.

- significant reduction in required LCAC underway training time.

- available for refresher training and ACV Research and Development.

- high training devices utilization.
- provides back-up training capability for procedures practice if more complex devices are not available.
- high training transfer from training devices to the LCAC.
- provides simulation and craft full team training capability.

The disadvantages of this approach include:

- facilities impact for all devices.
- minor to moderate technology risk.
- requires craft underway time to and from training area.

With the major result of reduced LCAC utilization in training at significantly lower operating cost versus training craft utilization, the analysis team believes this suite should be integrated into the long-term LCAC training system. This report will become finalized when a decision concerning training device procurement is reached. Regardless, it should be pointed out that the approximately four years remaining to design, develop, fabricate and deliver the Full Mission Trainer leaves the potential requirement of a two-phase training device implementation. In this case, the two less sophisticated devices in the recommended mix offer significant advantages in LCAC utilization reduction for the first phase over other combinations.

Thus, a decision regarding long-term LCAC training device procurement should receive priority attention. The impact of this decision will be felt by many of the ISD process steps recommended for this program in other ACVOTS training analysis products.

ACKNOWLEDGEMENTS

The Naval Training Equipment Center (NAVTRAEQUIPCEN) was tasked by David Taylor Naval Ship Research and Development Center (DTNSRDC) Code 1180 to perform this Simulator Requirements Analysis during the period of January 1982 through June 1982. Overall guidance was provided by Mr. Michael Sekellick, DTNSRDC Code 1181.1, and the Analysis Manager was Mrs. Carol Denton, NAVTRAEQUIPCEN Code N-252. The principal investigators were Mr. Wayne Hostetter and Mr. Robert Baker of Allen Corporation of America. Additional technical support and training analysis was provided by Mr. John B. Keegan and Ms. Anita M. Rossi, also of Allen Corporation of America.

The authors are indebted to the former Officer in Charge of the Navy's AALC ETU, Lt. Commander Kenneth Shafer and the ETU Training Coordinator, Mr. John Auzins for their assistance in providing technical information. The authors are also indebted to the following individuals and their respective organizations for their valuable assistance:

Mr. Gene Miller, and
Mr. Peter Van Dyke, Hydronautics, Inc.;
Mr. Max Carpenter, IOMMP Maritime Institute;
Mr. Ron Gress, and
Mr. Dave Walden, U.S. Coast Guard;
Mr. Tom Garrigen, Marine Safety International;
Mr. Robert Nissley, and
Mr. Cecil Groover, Bell Aerospace Textron;
Mr. Joseph Puglisi, CAORF, U. S. Merchant Marine Maritime Academy;
Mr. C. W. Harry, Code 1183,
Mr. Richard F. Messalle, Code 1562,
Mr. Henry J. Haussling, Code 1843, and
Mr. Richard T. VanEseltine, Code 1843, DTNSRDC.

Special acknowledgement is due the officers, enlisted and civilian personnel of the ETU who were extremely helpful in providing information essential to this analysis.

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SECTION I
INTRODUCTION

OVERVIEW

The Air Cushion Vehicle Operator Training System (ACVOTS) program is planned to identify and fully define, test, evaluate and document Air Cushion Vehicle (ACV) operator training devices and systems.

Two advanced development ACVs, designated JEFF(A) and JEFF(B), are currently being tested under the Navy's Amphibious Assault Landing Craft (AALC) Research Development Test and Evaluation (RDT&E) program. These craft were designed and built to develop the technology and assess the feasibility and military utility of employing ACVs in amphibious assault. The follow-on design and procurement of the production craft are being accomplished under the Landing Craft, Air Cushion (LCAC) acquisition program. These LCAC craft are intended to be operated by an all enlisted man crew. Navy follow-on training for the LCAC is projected to start in 1986.

The LCAC was the first design chosen for acquisition and fleet introduction in quantity. Other advanced craft with different payload and performance characteristics are now under consideration, and limited model tests and design studies have been undertaken. Thus, in the far term, other advanced craft, possibly ACVs, will also reach acquisition and fleet introduction in addition to LCACs. These craft are referred to as Landing Craft Experimentals (LCXs).

BACKGROUND

This ACVOTS simulator requirements analysis was sponsored under the direction of the David Taylor Naval Ship Research and Development Center (DTNSRDC), Code 118, Bethesda, Maryland. Technical direction was provided by the Naval Training Equipment Center (NAVTRAEQUIPCEN), Code N-252, Orlando, Florida.

The objectives of the study were to determine the types and characteristics of training devices to support ACVOTS long-term LCAC operator training. Long-term LCAC operator training encompasses Navy follow-on training of LCAC crews beyond that provided by the craft manufacturer for the initial six craft and extends through the life cycle of the LCAC weapons system. Since the Navy intends to pursue the use of ACV technology in its amphibious landing craft

fleet, it is important that a training- and cost-effective approach to training operating crews of this craft class be developed. Furthermore, since the first system being procured is the LCAC, it is justifiable and, in fact, fundamental, to use it as a test bed for ACVOTS development. The initial application and validation of ACVOTS methods and procedures in the long-term LCAC program will provide a validated baseline from which future ACV training programs can be developed. It is anticipated that short and mid-term LCAC operator training program development will also benefit from ACVOTS efforts. The data and analyses results presented in this report provided the foundation from which the training device recommendations presented in Section IV were formulated.

This simulator requirements analysis is only one activity in the entire analysis phase of the ACVOTS program. The entire analysis phase will contribute to the overall design of the ACVOTS long-term LCAC operator training program. Other activities in this phase include the following:

- Problem Analysis (PA).
- Training Development and Support Plan (TDSP).
- Task Listing.
- Student Entry Level Analysis.
- Training Equipment Survey.
- Objectives Hierarchies.

Each of these activities have either been completed or are presently underway. The ACVOTS Problem Analysis Report (PAR)[1], draft TDSP, and draft task listing provided input into the conduct of this analysis.

SYSTEM DESCRIPTION

The description of the LCAC contained in the following paragraphs was extracted from the LCAC Navy Training Plan (Draft)[2].

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[1] ACVOTS Problem Analysis, Technical Memorandum 82-2, Naval Training Equipment Center, November 1981

[2] LCAC Navy Training Plan (Draft), PMS-377, Amphibious Ship Acquisition Project, Naval Sea Systems Command, Washington, D.C., November 1981.

The LCAC is a high speed ship-to-shore/over-the-beach vehicle that will deliver a 60-ton payload to the ground elements of a Marine Amphibious Force at 40 knots in sea state 2. It will be launched from amphibious assault ships (LSDs, LHAs, and LPDs) at increased standoff distances. The LCAC can transport equipment, personnel, and weapons systems (including the main battle tank) through the surf zone, to the shore, and across the beach for a dry landing. It will provide the Navy/Marine Corps with high-speed delivery capabilities to support amphibious operations. It is anticipated that the LCAC will replace conventional landing craft (LCU, LCM-8, LCM-6). A specific replacement schedule, however, has not yet been promulgated by the Chief of Naval Operations.

The LCAC is a follow-on fleet version of the JEFF(B) craft that will provide greatly improved operational performance characteristics over existing (World War II design) amphibious landing craft. Improvements in ease of loading, transit speeds, and operations in unrestricted surf and beach conditions will be enhanced by improved operational availability resulting from a design based on realistic reliability and maintainability goals. This craft, with an integrated lift and propulsion system, uses many of the JEFF(B) proven components.

It is anticipated the LCAC operator tasks will not change significantly from those of the JEFF(B) with the exception of the addition of operational concept tasks which have not yet been fully defined. Although the majority of tasks will be the same between the two craft, it is anticipated there may be minor changes in the skills and knowledge components of these tasks.

SCOPE

This analysis addresses simulation requirements for conducting long-term LCAC operator training. The long-term training includes both complete initial qualification and follow-on continuation training. Consideration of student entry skills was based on a range of students entering the program from those without any craft operator experience to those who possessed prior ACV operator experience. Simulation training was considered for both afloat and ashore facilities; however, the recommendations in this report are only for shore facilities. The investigators believe that simulation benefits at sea would be off-set by the maintenance and logistics problems that would be incurred.

During development of the simulator requirements analysis task listing, it became evident that the operator and engineer participate as a team in the majority of tasks encompassing both normal and emergency/abnormal procedures. Therefore, the recommendations in Section IV of this report include both the operator and engineer crew positions.

Certain assumptions were made and constraints identified in the conduct of this analysis and are as follows:

ASSUMPTIONS.

- Simulation utilization is based on device availability of 240 training days, 16 hours a day and student initial pipeline flow of twelve students per year until the early 1990s at which time it could increase to as high as 54 students per year.

- Student pipeline sources will include students with and without prior ACV experience.

- The JEFF(B) is a viable source for baseline data required to conduct this analysis.

- Maximum cost effectiveness of the long-term LCAC operator training program will be achieved through placing as many training requirements as possible into the academic and training device areas and training only those remaining training requirements in a training and/or operational craft.

- Cost trade-offs would be conductd for simulator(s) vs craft without considering facilities costs. Facility costs for training devices would be off-set by facility requirements for additional craft required for training, if simulators were not included in the training program. In addition, final basing decisions may include bases which have existing facilities available for simulators.

- Underway training time should be minimized because of safety considerations (single seat control) in traffic congested areas, high craft operating costs and potential noise and other environmental impacts.

CONSTRAINTS.

- LCAC operational and engineering data were not available; therefore, the analysis was conducted using the JEFF(B) as a baseline.

- The LCAC mission concept has not been finalized, and thus, is not available. This constraint prevented definition of some mission tasks for assessment during the conduct of this analysis.

- The lack of analogous ACV operational systems prevented use of previous ACV simulator requirement analysis procedures. Thus, this analysis is the first ACV simulator requirements analysis performed.

- Certain tasks have not been performed in the AALC Research and Development (R&D) environment that will be accomplished in the operational environment. (e.g. over land operations at night).

It should be noted that the cost estimates and technical specifications for training devices presented in this report are rough order of magnitude, rather than precise figures, for use in supporting simulation cost/benefit indicators. Performance specifications should be used to procure LCAC operator training devices. Industry may therefore, respond with a wide range of simulation techniques which vary significantly in cost.

REPORT ORGANIZATION

This report is presented in two volumes. The remainder of Volume I is organized and sequenced as follows:

- SECTION II, TECHNICAL APPROACH. Description of the activities performed during the study to identify long-term LCAC operator training devices.

- SECTION III, RESULTS. Presentation of the analysis results which support the training device recommendations.

- SECTION IV, RECOMMENDATIONS. Presentation of training device recommendations and supporting rationale for the long-term LCAC operator training.

Volume II contains:

- APPENDIX A, ACVOTS OPERATOR TRAINING DEVICE OBJECTIVES. Listing of ACV operator training device tasks and supporting criterion objectives.

- APPENDIX B, SIMULATION STATE-OF-THE-ART ASSESSMENT FOR AIR CUSHION VEHICLES. Description of simulation state-of-the-art and candidate simulation component recommendations for the long-term LCAC operator training program.

- APPENDIX C, ACVOTS TRAINING DEVICE FUNCTIONAL DESCRIPTIONS. Preliminary functional descriptions of candidate training devices which will support ACV operator training beginning with the long-term LCAC operator training.

- APPENDIX D, CONCEPTUAL DRAWINGS OF AIR CUSHION VEHICLE TRAINING DEVICES. Conceptual drawings of the CFT, PTT1A, PTT1B, CPT, PTT2, OUT and FMT.

- APPENDIX E, ACVOTS TRAINING DEVICE AND TRAINING DEVICE MIX (ES) COST ESTIMATES. Results of cost analysis as discussed in Section III.

SECTION II
TECHNICAL APPROACH

OVERVIEW

The Simulator Requirements Analysis (SRA) is one of the steps in the ACVOTS analysis phase. In order to perform the SRA, LCAC operator training requirements were assessed and allocated to candidate training devices. The result was the identification of recommended and alternative training device mixes capable of providing effective hands-on training and reducing the need for dedicated craft for underway training. The analysis systematically compiles relevant data, defines training requirements, and matches the requirements with current and projected near-term training device capabilities. In addition, the analysis provided critical information for trade-off and cost studies of current and projected training device technologies.

The process employed as a guide for this analysis is described in a draft simulator requirements analysis military specification[3], which is applicable to both existing and emerging weapons systems. It is also consistent with the Instructional Systems Development (ISD) procedures specified in MIL-T-29053B(TD)[4], and other similar military ISD specifications. Figure 1 illustrates the sequence of simulator requirements analysis steps within the ISD process. Although the draft specification was used as a guide, procedural steps were modified or added as considered appropriate.

Simulator requirements analysis process steps are as follows:

- TRAINING DEVICE TASKS
  - -- Problem Analysis Report (PAR) Review
  - -- Training Development and Support Plan (TDSP) Review
  - -- Training Equipment Survey Visits
  - -- Task Listing Development
  - -- Identification of Training Device Tasks

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[3]Procedures for Simulator Requirements Analysis, (MIL-T-XXXXX), Naval Training Equipment Center, 15 December 1981.

[4]Requirements for Training System Development, MIL-T-29053B(TD), Naval Training Equipment Center, 15 June 1981.

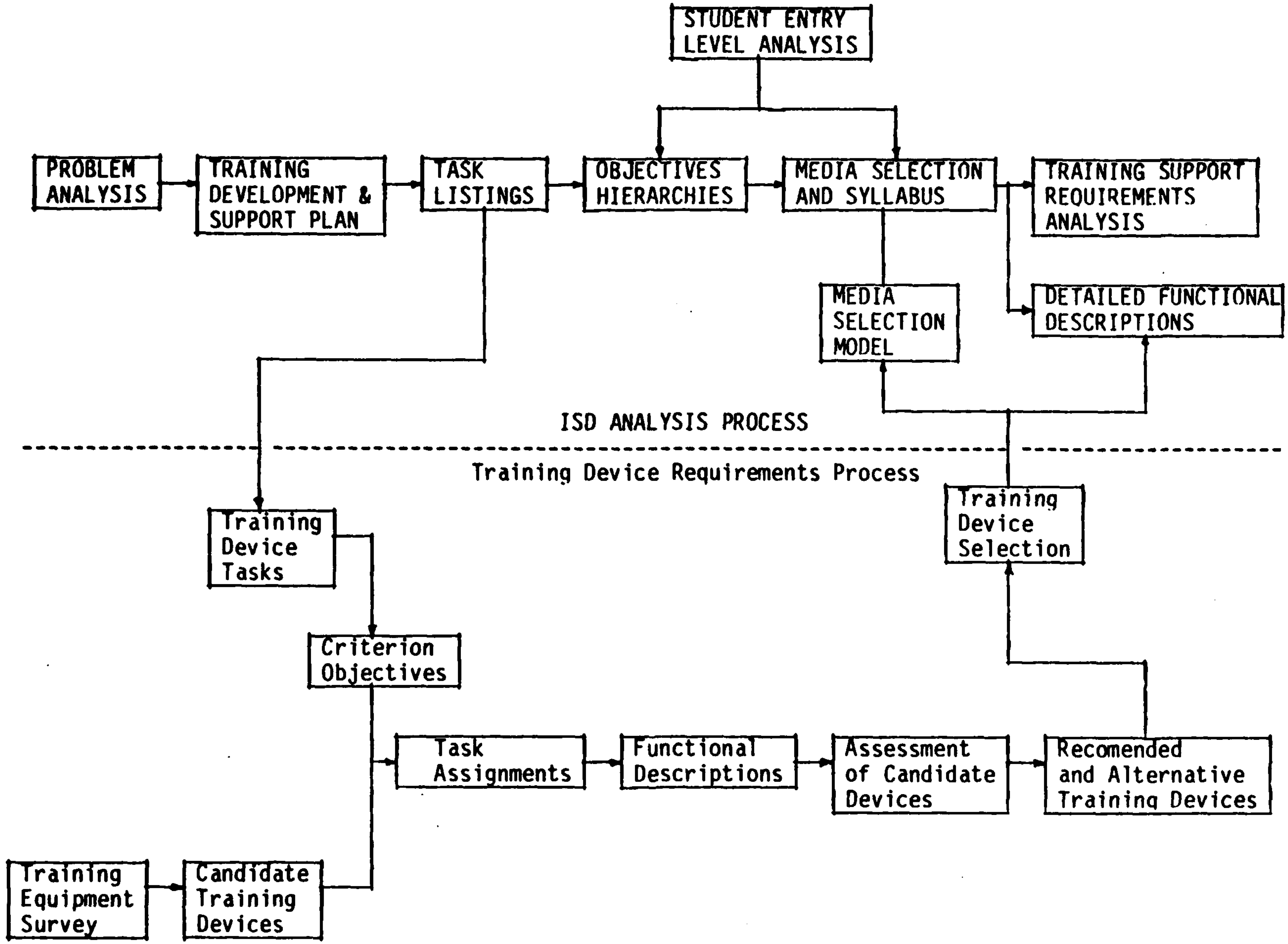

Figure 1. Sequence of Simulator Requirements Analysis Steps Within the ISD Analysis Process.

-- Annotation of Training Device Task Performance Cues

-- Gathering of Training Device Task Performance Conditions and Standards Data.

- CANDIDATE TRAINING DEVICES

  -- Identify ACVOTS Training Device Categories

  -- Develop Working Definitions for Candidate Training Devices

- CRITERION OBJECTIVES

  -- Develop Criterion Objectives for Training Device Tasks

- TASK ASSIGNMENTS

  -- Notation of Training Device Deficiencies By Task

  -- Calculate Task Completion Percentages and Hour Utilization Ratings for Candidate Training Devices

  -- Develop Data Base for Final Task Sort

  -- Conduct Final Task Sort

- FUNCTIONAL DESCRIPTIONS

  -- Develop Functional Descriptions for Candidate Training Devices

- ASSESSMENT OF CANDIDATE TRAINING DEVICES

  -- Determine Total Training Hours for Candidate Training Devices

  -- Estimate Procurement and Operating Costs for Candidate Training Devices

  -- Identify Candidate Training Device Mixes

  -- Determine Total Training Hours and Costs for Candidate Training Device Mixes

  -- Determine Training and Cost Advantages and Disadvantages for Candidate Training Devices and Mixes

- RECOMMENDED AND ALTERNATIVE TRAINING DEVICES

  -- Determine Recommended and Alternative Candidate Training Device Mixes

- TRAINING DEVICE SELECTION
  - -- Recommended Training Device Mix
  - -- Selection of Training Device Mix

The purpose and description for each of these steps are contained in the following paragraphs and the results are described in Section III.

APPROACH

TRAINING DEVICE TASKS. Results from ongoing ACVOTS analysis were reviewed, and supplemental data was generated where required. Descriptions of each step in this activity follow.

Problem Analysis Report (PAR) Review. The ACVOTS PAR was reviewed to assess the long-term LCAC operator training program development recommendations as to their applicability in the conduct of this analysis. The PAR recommendations were categorized into four major areas including detailed integrated planning, new training approaches, training development, and, other relevant training development areas. In addition, the assessment of the current AALC training program was reviewed to assist in determining whether or not simulation would be a viable training approach in future ACV operator training programs beginning with the long-term LCAC operator training program.

Training Development and Support Plan (TDSP) Review. The ACVOTS TDSP was reviewed to determine if the established training development milestones would be responsive in providing data required in the different phases of the simulator acquisition process. This is necessary as there is a close relationship that must be adhered to in order to achieve the goal of procuring the most training effective training devices for the least cost.

Training Equipment Survey Visits. A formal ACVOTS training equipment survey is being completed. The emphasis in that survey, however, is on possible low-cost commercial ACV craft which could be used for lead-in ACV training, and does not include simulation. Thus, a mini-survey was conducted during this analysis to accurately assess the state-of-the-art in ship simulation.

Of particular interest was the investigation of the state-of-the-art in hydrodynamic modeling from both analytical and empirical perspectives as well as the available simulation computer update rates required to simulate high speed ACVs in open and closed water and land operations.

The survey included visits to simulation facilities and consultation with experts in the field of numerical solutions to hydrodynamic problems. The facilities visited were:

- David Taylor Naval Ship Research and Development Center (DTNSRDC).
- Hydronautics Incorporated.
- International Order of Masters, Mates, and Pilots (IOMMP) Maritime Institute.
- United States Coast Guard Headquarters.
- Computer-Aided Operations Research Facility (CAORF) of the United States Merchant Marine Maritime Academy.
- Marine Safety International.

Task Listing Development. As a key element in defining total, long-term LCAC operator training requirements, the task listing must identify all LCAC operator tasks, subtasks and behavioral procedures. It is important to note that the task listing to support this analysis is necessarily more extensive than one developed for a training system which does not include acquisition of training devices.

Due to the non-availability of LCAC operations and engineering data, the task listing was developed using JEFF(B) data and subject matter experts (SMEs) who are presently operating the JEFF(B) craft at the AALC ETU. Development of the task listing began with a review of the Top Level Requirement (TLR) to define a generic ACV assault mission. The non-existance of an approved LCAC operational concept led to the definition of a generic ACV assault mission, less specific LCAC operational mission tasks. This generic mission was then divided into meaningful phases. Using these phases as a guide, a detailed listing of all operator and engineer tasks, subtasks, and procedural activities was prepared. For this detailed task listing, the algorithm provided in MIL-T-29053B(TD) was applied to identify tasks and subtask relationships. This algorithm is illustrated in Figure 2. Upon completion, the task listing was reviewed by SMEs to verify completeness and accuracy.

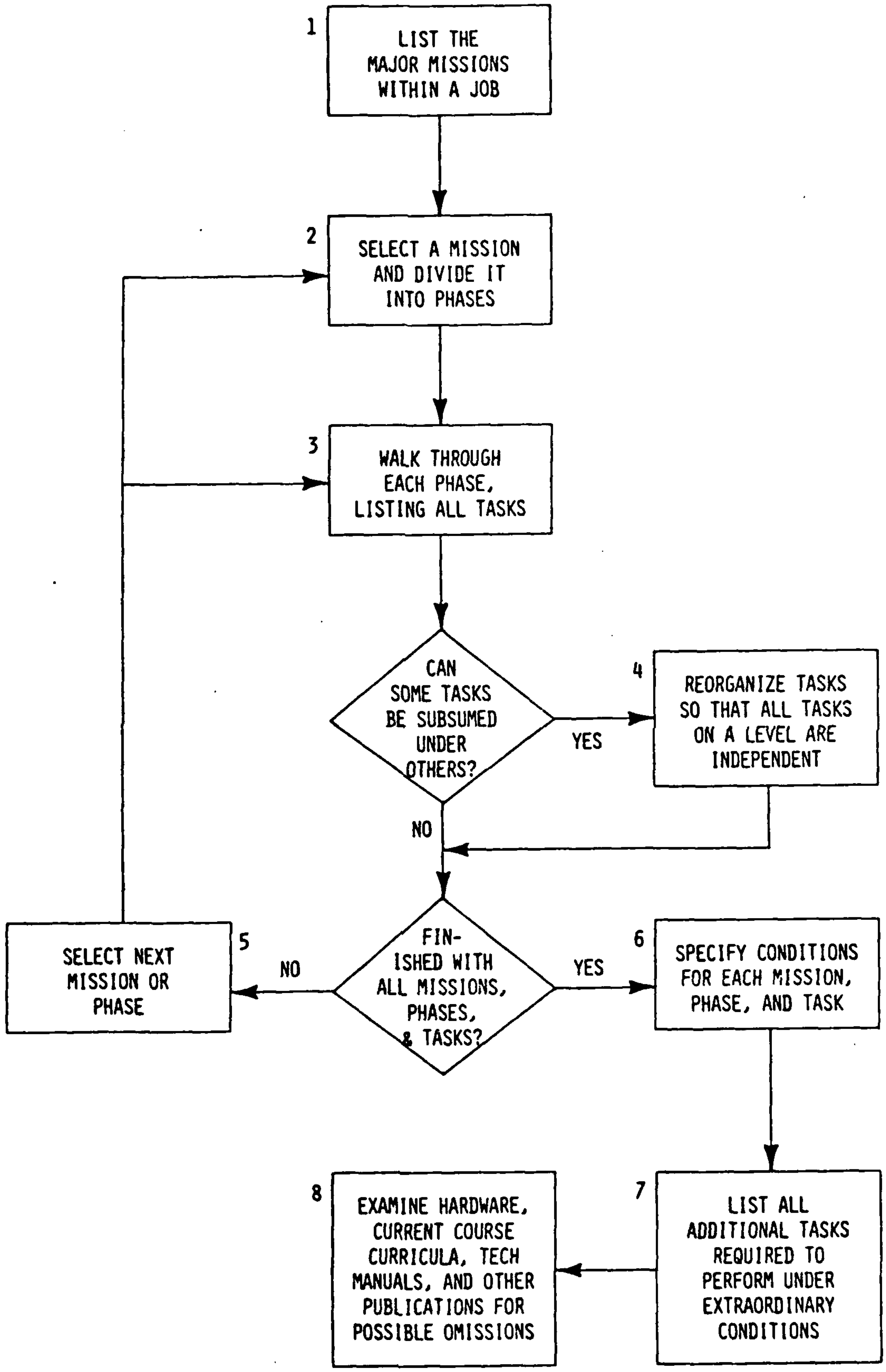

Figure 2. MIL-T-29053B(TD) Task Listing Algorithm

Identification of Training Device Tasks. During development of the task listing, primary emphasis was placed on identification of hands-on LCAC operating tasks and their subordinate subtasks and procedures as opposed to areas such as mission planning, mission briefing, etc. Therefore identification of hands-on tasks was accomplished simultaneously with the task listing development. Each hands-on task was then analyzed to identify whether or not it could be taught in some type of training device; this was a subjective decision based on the knowledge of the training of the task, state-of-the-art of simulation, and ACV craft operation.

Annotation of Training Device Task Performance Cues. Each hands-on task selected as a candidate for simulation was further analyzed to identify more detailed characteristics. Specific task parameters quantified in this analysis included:

- Task Mission Performance Criticality,
- Task Learning Difficulty,
- Frequency of Task Performance,
- Student Entry Level Skills (Note: These skills have not been totally defined at present. Therefore, in some cases, estimation and extrapolation from current data was necessary),
- Frequency of Practice Required to Achieve and Maintain Proficiency,
- Interrelationships Among Tasks,
- Complexity of Cues Related to Task Performance, and,
- Capability of Simulation State-of-the-art to Support Task Training Requirements.

Each parameter was defined for each task in the task listing. Results were then reviewed by JEFF(B) operators for verification. Required modifications were made during this validation activity.

Major tasks were analyzed to identify visual, audio, and motion cues involved in task performance. This analysis was conducted using task cue worksheets. An example of this worksheet is shown in Figure 3. The worksheets were annotated jointly by contractor personnel and AALC ETU SMEs. Cue presence (Yes/No) and importance (Primary/Secondary) were recorded. In

TASK NUMBER ______________ TASK STATEMENT ______________________________

VISUAL CUES	Y/N	P/S
INTERNAL		
1. Instruments		
2. Switches		
3. Lights		
4. Other		
EXTERNAL		
5. Velocity		
6. Distance		
7. Shape Recognition		
8. Positional Relationship		
9. Wave height		
10. Surf line		
11. Water surface		
12. Land surface		
13. Rain		
14. Fog		
15. Day		
16. Night		
17. Other		
SCALE		
18. Exact scale		
19. Proportional scale		
FOV		
20. Vertical Specified number of degrees up and down from design eye		
21. Horizontal Specified number of degrees left and right from design eye		

AUDIO CUES	Y/N	P/S
CRAFT		
22. Engines		
23. APU		
24. Transmissions		
25. Propeller pitch		
26. Bow Thrusters		
27. Hull (on cushion)		
28. Hull (off cushion)		
29. Other		
INTERNAL COMMUNICATION		
30. Voice		
31. Interphone		
32. Other		
EXTERNAL COMMUNICATION		
33. Radio (UHF/VHF/HF)		
34. Navigation aids		
35. Other		
HOSTILE FIRE		
36. Incoming shells		
37. Mines		
38. Torpedoes		
39. Other		
ENVIRONMENTAL		
40. Sea		
41. Wind		
42. Rain		
43. Sand		
44. Other		

MOTION CUES	Y/N	P/S
INTERNAL		
45. Control yoke frictional force		
46. Rudder pedals frictional force		
47. Other		
EXTERNAL		
48. Roll		
49. Pitch		
50. Yaw		
51. Sway		
52. Surge		
53. Heave		
54. Vibration		
55. Other		

NOTES:

Figure 3. Task Cue Worksheet

addition to the cue categories shown in Figure 3, supplementary information was gathered and annotated in the notes section of the worksheets. This information included four of the parameters previously identified:

- Tasks mission performance criticality.
- Number of repetitions required to achieve task proficiency.
- Number of repetitions required to maintain task proficiency.
- Crew interaction requirements.

After all task data was gathered and annotated, SMEs identified minimum and maximum times required to perform each task under normal operating conditions. These times were also annotated in the notes section of the task cue worksheets.

Hands-on tasks were then analyzed to determine if they were potentially trainable using training devices. For example, the task "bringing the craft on-cushion" possesses the following characteristics:

- Critical to mission performance.
- Learning is reasonably difficult (given wind direction, speed, and resultant required control).
- Performed at least twice during the generic mission (once before departure at the base or support ship, and once at the unloading site).
- Entry level skills are essentially unavailable (no other similar operational ACVs in the Navy inventory other than the JEFF craft).
- Should be performed frequently because of wind effects.
- Task is part of a larger scenario, but could be practiced in concert with bringing the craft off-cushion and stationary maneuvering only.
- Performance cues are judged sufficiently complex that a full control station with real world representation is necessary for practice.

<u>Gathering of Training Device Task Performance Conditions and Standards Data.</u> Those tasks which passed through the above analysis were then analyzed to determine detailed conditions and standards of performance. These conditions and standards are necessary inputs to the development of criterion objectives and functional descriptions for candidate training devices. A criterion

objective is one which communicates (1) what task is to be performed; (2) to what proficiency level; and (3) the conditions under which the task is to be performed. Conditions and standards were developed for each selected task using the task cue worksheets, the JEFF(B) operators' manual[5], and JEFF(B) operator SMEs from the AALC ETU. To completely describe the conditions and standards for each task, a worksheet was developed as shown in Figure 4. The goal of this activity was to document the required information from which a comprehensive criterion objective could be developed for each selected task.

Due to the developmental nature of the JEFF(B), some standards could not be completely established. Many tasks such as "enter/exit well deck" have been performed only a limited number of times. The level of detail established, however, was sufficient to develop preliminary functional descriptions for candidate training devices.

CANDIDATE TRAINING DEVICES. A brief description of the component activities of this step follow.

Identify ACVOTS Training Device Categories. Results of the training equipment mini-survey identified the range of potential training device categories capable of ACV operator, engineer, and navigator training. Further, that survey and a literature search contributed to the definition of training device categories. Other factors contributing to the definition of the training device categories included:

- General types of devices currently in production for the surface and aviation communities,
- Special anticipated ACV training requirements, including shipboard refresher training and limited availability of operational craft for training,
- Tri-service (Navy, Air Force, Army) definitions of training device classification, and
- Training situation constraints (safety, environment, etc.).

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[5]AALC JEFF(B), Operators Manual, Bell Aerospace Textron Report No. 7385-927036, Contract No. N00024-21-C-0276, revised August 1979.

Task # ________ Task Statement ________________________________

CONDITION FACTORS:	
Station Characteristics	
Environmental	
External	
Others	
Equipment	
Information	
Initiating	
Completion	
Interrelationships/ Dependencies	
STANDARD FACTORS:	
Controls used	
Instruments/displays monitored	
Time/Speed	
Accuracy/error rate	
Safety	

Figure 4. Conditions and Standards Worksheet

Develop Working Definitions for Candidate Training Devices. Using the results of the preceding activity, the list of potential training device categories was reduced to a final set of candidate devices which reflect the constraints of anticipated long-term LCAC operator training requirements in terms of feasibility and realism. In addition, these identified candidate training devices are viewed as possessing capabilities which could, either by themselves or within training device mixes, contribute to improved long-term LCAC operator hands-on task performance.

Once the candidate training devices were identified, working definitions were developed to describe the higher level capabilities of the devices. From these definitions, it was possible to determine specific device capabilities/limitations for each task behavior - the first activity in the task assignment process. Further, it provided the foundation for preliminary device functional descriptions, which were developed later in this process.

CRITERION OBJECTIVES. The purpose of this step was to develop criterion objectives for each task training device to facilitate communication between instructional developers, simulator engineers, and Navy technical and managerial personnel.

Develop Criterion Objectives for Training Device Tasks. The information required to develop the criterion objectives was obtained from the conditions and standards worksheets, and supplemented with information from the task listing, task cue sheets, and JEFF(B) operator's manual. These objectives were developed by contractor training analysts/technicians and reviewed by contractor senior training analysts and the program manager. Final review was accomplished by Naval Education Specialists.

TASK ASSIGNMENTS. The assignment of each task to one or more training devices encompassed an extensive documentation effort to ensure an audit path was provided for each task assignment. Each activity within this process step is briefly described in the following paragraphs.

Annotation of Training Device Deficiencies. Each candidate training device was reviewed for its capabilities to train each task including all subtasks and subordinate behaviors. Specific device visual, audio, motion, and tactile

cuing deficiencies/limitations were defined for each task/subtask and subordinate behaviors through review of the task listing, task cue worksheets, conditions and standards worksheets, and task criterion objectives. Specific device deficiencies/limitations were annotated for each task on the task listing. An example of this process is presented in Figure 5.

Calculate Task Completion Percentages and Utilization Ratings for Candidate Training Devices. A rating was assigned to each task for each candidate training device based on the percent of task/subtasks and behaviors which could be completed for each respective device. This rating was based on an 0 - 5 scale. These ratings were determined through the use of a training device rating criteria worksheet as shown in Figure 6. The percent of remaining subtasks for each task which possesses procedural practice elements, the limitations created by missing or degraded cues, and the cues limited by simulation state-of-the-art were analyzed to determine the rating of subtasks which could be completed on each device for each task. These ratings were entered into a data base which was used to complete the final sort of tasks to training devices.

Develop Data Base for Final Task Sort. Using the results of the first two activities of this process step, a data base was entered into a word processor for the final task sort. In addition to the information in the first two activities, number of task repetitions to attain and maintain proficiency, crewmember interactions, and task completion times were entered into the data base.

Conduct Final Task Sort. Tasks were assigned to candidate training devices by use of a word processor using the task data base developed in the previous activity.

FUNCTIONAL DESCRIPTIONS. Functional descriptions were developed for each of the candidate training devices. Prior to developing these descriptions, a format was developed based on the guidelines in the draft specification, other functional descriptions developed for both emerging and existing weapons systems training devices, and inputs from NAVTRAEQUIPCEN simulation development engineers. It is important to note that in past training device

Task	CFT	PTT1	CPT	PTT2	OUT	FMT
<u>4.1.3.3</u> <u>Perform Beach to Surf Transition</u>	CFT* ** ***[3]	No	CPT***[3]	PTT2[4]	OUT[4]	FMT[4]
4.1.3.3.1 Set bow thrusters REV	CFT*	No	CPT	PTT2	OUT	FMT
4.1.3.3.2 Apply Prop pitch for low speed FWD	CFT*	No	CPT	PTT2	OUT	FMT
4.1.3.3.3 Time surf entrance to miss cresting waves	No	No	No	PTT2[4]	OUT[4]	FMT[4]
4.1.3.3.4 Verify vernier pitch ON	CFT*	No	CPT	PTT2	OUT	FMT
4.1.3.3.5 Hold speed at or below 20 knots	CFT**[3]	No	CPT[3]	PTT2	OUT	FMT
4.1.3.3.6 Maintain heading 5° to 45° to Port of surf line	CFT***	No	CPT***	PTT2[4]	OUT[4]	FMT[4]
4.1.3.3.7 (Beyond surf zone) Set bow thrusters FWD	CFT* ***	No	CPT***	PTT2[4]	OUT[4]	FMT[4]
4.1.3.3.8 Accelerate to cruise speed	CFT**[3]	No	CPT[3]	PTT2	OUT	FMT
4.1.3.3.9 Verify Vernier pitch ON or OFF, as required	CFT*	No	CPT	PTT2	OUT	FMT

*Dummy Switches/controls
**And Indications (dials, gauges, etc.)
***External cues

[3]Engine Math Model
[4]Limited by quality of wave simulation

Figure 5. ACVOTS Sample Task Listing/Device Annotation

RATING	Percent of sub-tasks completed on device.	Percent of remaining sub-tasks possessing procedural practice element.	Limited by missing or degraded cues.	Cues simulation limited by State-of-the-art.
0	0%	less than 50%	-	-
	0%	more than 50%	-	-
1	1%-25%	-	-	
	26%-50%	-	X	-
	1%-25%	more than 50%	-	-
2	26%-50%	-	-	-
	51%-75%	-	X	-
	26%-50%	more than 50%	-	-
3	51%-75%	-	-	-
	76%-100%	-	X	-
4	76%-100%	-	-	X
5	100%	-	-	-

Figure 6. Training Device Rating Criteria Worksheet

procurements, the functional descriptions have usually communicated to the training personnel; however, many times they have not adequately communicated to the engineers who design the engineering specifications. Therefore, particular emphasis was placed on ensuring the adequacy of these functional descriptions.

Develop Preliminary Functional Descriptions for Candidate Training Devices. Data sources for this activity included the task listing with annotations, task cue worksheets, conditions and standards worksheets, criterion objectives, JEFF(B) operators' manual, and NAVTRAEQUIPCEN simulation development engineers. Results were reviewed by contractor simulator engineering and training development personnel.

ASSESSMENT OF CANDIDATE TRAINING DEVICES. In order to make the best objective decision as to the most training- and cost-effective training device mix, a detailed assessment of each of the candidate training devices was made. This assessment was accomplished through five separate and comprehensive activities as described below.

Determine Total Training Hours for Candidate Training Devices. Data gathered on the length of time required to complete one repetition of each task, and the number of repetitions required to reach proficiency was used to complete this activity. The total number of hours required by the JEFF(B) training system to achieve proficiency over all tasks was calculated from the above data.

The time required for each task was multiplied by the percentage-based rating of that task for each specific device, and these products for all tasks were summed for each candidate training device. This provided an estimate of the total number of training hours each device could be utilized.

Percentages derived from the ratings contained on the training device criteria worksheets, as shown in Figure 6, were used rather than the actual percentages in order to permit easier computations to be made. As an example, a rating of 3 converts to 60%. Use of the rating-derived percentages resulted in the possibility of error estimated to be no greater than plus or minus 19 percent on any single task/device estimation.

Estimate Procurement Costs for Candidate Training Devices. Order of magnitude cost estimates for each candidate training device were developed by contractor simulator engineer personnel based on costs of recently procured training devices with similar capabilities. It is recommended that after a decision has been reached as to which training device(s) will be used in the long-term LCAC operator training program that more accurate cost estimates should be obtained from selected simulator manufacturers for further comparisons.

Identify Candidate Training Device Mixes. Realistic combinations of candidate training devices were considered in order to determine whether or not various mixes of devices were more or less cost-effective than a single device. The maximum number of mixes were defined for each training device. Guidelines and results of this step are presented in Section III.

Determine Total Training Hours and Costs for Candidate Training Device Mixes. The total number of hours which could be used to train a student was calculated for each candidate training device mix. The assumption that guided this activity was that less sophisticated devices would be used as much as possible to reduce the training burden of the next most sophisticated device in the mix. This determination was made on a task by task basis including subordinate subtasks and behaviors. This provided the option by which tasks and subtasks could be divided between devices.

The cost of utilizing each device as the sole training device was calculated. This cost is the product of the number of hours which could be trained on the device times the hourly operating cost of the device. Several factors are involved in calculating the hourly operating costs. The following formula was used in calculating the cost of using each device by itself assuming that the remaining training hours will be accomplished in an LCAC craft.

$$\frac{\text{Cost}}{\text{Year}} = \frac{\text{Procurement Cost}}{\text{Amortization}} + \left[\left(\begin{matrix}\text{Number}\\ \text{of}\\ \text{Trainee}\\ \text{Hours}\end{matrix} \times \frac{\text{Number of Training Hours}}{\text{Trainee}}\right) \times \left(\frac{\text{Utility Cost}}{\text{Hour}} + \frac{\text{Instructional Staff Cost}}{\text{Hour}} + \frac{\text{Maintenance Cost}}{\text{Hour}}\right)\right]$$

Amortization rate was taken to be 15 years for all devices and the LCAC. Separate calculations were made for the training of 12 and 54 trainees. Staff

costs for instruction were estimated to be $30.00/Hour and for maintenance $20.00/Hour. Utility costs were estimated to be $0 to $4.50/Hour based on a rate of $.075 per kilowatt hour and depending on the device being costed.

Mixes of devices were then defined from all permutations following a set of guidelines. Training contribution of each device within each mix was evaluated via an analysis of the behavior level impact of each successively more complex device within each mix. Guidelines and assumptions used, as well as examples of this methodology are presented in Section III.

Next, the cost of using each candidate training device mix was calculated. This was accomplished by calculating the maximum utilization and resultant operating cost for each device in each mix. All remaining training hours were assigned to the LCAC craft. The formula for calculating the cost of each candidate training device mix was the same as used before.

The amortization rate, staff costs for instructors and maintenance, and utility costs for each device were the same as used in the previous calculations. Calculations were made for training 12 or 54 trainees per year.

Determine Training and Cost Advantages and Disadvantages for Candidate Train- Devices and Mixes. Based on the results of all the previous steps, training and cost advantages and disadvantages were determined for each candidate training device and candidate training device mix. Each candidate training device was analyzed individually for its training potential versus its cost effectiveness. Then, each mix was analyzed using the same criteria. This activity, in essence, summarized the results of all the previous steps, thereby forming the foundation for determining the recommended and alternative training devices for the long-term LCAC operator training program.

RECOMMENDED AND ALTERNATIVE TRAINING DEVICES. The goal of this step was to develop recommendations as to the optimum and alternative training devices to be selected for the long-term LCAC operator training program. One activity comprised this step and is as follows:

Determine Recommended and Alternative Training Devices. A set of guidelines provided a structure for systematic selection of training device alternatives. These guidelines ensured all of the results from previous steps were

considered in determining the recommendations for this analysis report. These guidelines are as follows:

- Training requirement priorities - Capabilities that must be present in the selected devices to satisfactorily meet minimum training requirements.

- Resource Commitment priorities - Rules for cost effective ordering of alternatives.

- Minimum acceptable training effectiveness - Job functions which must be adequately trained to meet all underway training requirements.

- Minimize duplication across devices - Overlap of capabilities which would lead to inefficient use of resources.

- Device grouping requirements - Sets of devices which collectively meet all training requirements.

Each of these guidelines were reviewed against each candidate training device mix. The results of this step are the recommended and alternative training device mixes for the long-term LCAC operator training program as presented in Section IV of this report.

TRAINING DEVICE SELECTION. This report is finalized with all Navy inputs received. The criteria for the final mix is one which will produce the highest level of LCAC operator training proficiency for the least cost.

SECTION III
RESULTS

OVERVIEW

This section presents the results of the ACVOTS simulator requirements analysis conducted to identify long-term LCAC operator training program options incorporating candidate training devices. In addition, supporting rationale which resulted from the analysis is discussed.

RESULTS

TRAINING DEVICE TASKS. The results of this process step were the identification of all operator tasks which would be candidates for training via simulation. Results of each sub-step of this process are detailed below.

PAR Review. Review of the ACVOTS Problem Analysis Report indicated that operational and site-specific constraints to training ACV operators justified serious consideration of simulation for inclusion in any future ACV operator training system.

Constraints included:

- Rising fuel costs,
- Congested training base areas,
- Noise considerations,
- General safety considerations, and,
- Current estimates of student population entry level.

Elements of the PAR were used throughout the conduct of each of the remaining steps of the analysis.

TDSP Review. Review of the TDSP indicated that most, if not all, training devices specified for the long-term LCAC operator training program can be brought on line in time for the Navy takeover, projected to occur in mid-1986, if emphasis is given to their acquisition. A Navy decision to procure a fully

operational trainer or full mission trainer may result in a two-phase implementation of simulation due to slippages in accomplishing the four-step acquisition process. Elements of the TDSP were used throughout each of the remaining steps of the analysis.

Training Equipment Survey Visits. Visits were made to six different facilities. Brief statements of the goals of each visit are as follows:

- David Taylor Naval Ship Research and Development Center (DTNSRDC). Assess state-of-the-art in numerical solutions to specific ACV problems (maneuvering, control and performance) and ascertain whether an LCAC empirical math model can be developed.
- Hydronautics Incorporated. Review of mini-computer driven tug-tow barge simulation and discuss the math model which includes combined mass effects, wind and wave effects, tide, and current effects derived from actual U.S. Army Corps of Engineers data.
- International Order of Masters, Mates, and Pilots (IOMMP) Maritime Institute. Review of present simulator hardware and training and discuss their new simulator and its projected use.
- United States Coast Guard Headquarters. Review of modifications to the Hydronautics tug-tow simulator and its current and projected uses.
- Computer-Aided Operations Research Facility (CAORF) of the United States Merchant Marine Maritime Academy. Review of simulator hardware and its current and projected uses.
- Marine Safety International. Review of simulator hardware and its current and projected uses.

This survey revealed several significant facts. First, the use of ship simulation in general, and the state-of-the-art of ship simulation in particular, is behind that of the aviation community. However, the successes of the earlier programs have led to a growing acceptance of simulation application to ship helmsman training. It is now viewed as a viable and cost effective training approach. Second, even though there are job performance differences between a ship helmsman and an ACV operator, the types of simulation hardware and software requirements remain similar. Therefore, simulation is viewed to be a viable option for ACV training. Finally, the highest risk area in simulating an ACV is the math model required to replicate ACV operating and performance characteristics. This survey confirmed that a math model can be developed, for a reasonable cost, to simulate all ACV characteristics with the

exceptions of the fidelity requirements of breaking surf and seal bag effects in plow-in. A detailed discussion of the state-of-the-art in simulation as it applies to ACVs is presented in Volume II, Appendix B of this report.

Task Listing Development. A job task listing is the foundation of a simulator requirements analysis. It provides the basis for determining training requirements. When assessed against the various training media available (including the operational craft) specification of a fully integrated training system should result in which each medium is maximally utilized.

Because task listings for LCAC crew members do not exist, JEFF(B) data and subject matter expertise were relied upon to construct a generic assault mission and develop an operator task listing. It soon became apparent that the engineer position was heavily involved in the majority of operator tasks. It also became apparent that the task listing developed was primarily a hands-on task listing because of the sources used (i.e., JEFF(B) manual, qualified operators, etc.). The task listing[6] developed for this simulator requirements analysis involves over 1200 tasks, subtasks and procedural or psychomotor behaviors of which 946 are discrete performances contributing to the entire mission.

Identification of Training Device Tasks. For the purposes of this simulator requirements analysis, delineation of those tasks in the listing was required which:

- involve cues/responses which must be interpreted,
- involve safety as a training factor, or,
- involve costly operational craft underway time for training.

Tasks which passed through this analysis were considered simulation-capable and were further studied. A listing of these major tasks/subtasks is presented in Figure 7. Tasks which do not appear in Figure 7 but which are

[6] Air Cushion Vehicle Operator Training System (ACVOTS) Task Analysis (Draft), NAVTRAEQUIPCEN Report No. N-25-82-20, June, 1982.

3.1	Perform Pre-mission Checklist Procedures
3.1.52	Perform Control Cabin Inspection
3.1.53	Direct Operating Crew Station Manning
3.2	Start Craft
3.2.1	Perform Power-off Checklist Procedures
3.2.2	Perform APU Start Checklist Procedures
3.2.3	Perform Pre-start Checklist Procedures
3.2.4	Perform Main Engine(s) Start Checklist Procedures
3.3	Perform Pre-Underway Checklist Procedures
3.4	Perform Lift-off and Hover Checklist Procedures
4.1	Transit from Land to Water
4.1.1	Obtain Clearance as Required
4.1.2	Maneuver to Outbound Heading
4.1.3	Perform Land to Water Transition
4.1.3.1	Perform Ramp or Slipway to Smooth Water Transition
4.1.3.2	Perform Beach to Smooth Water Transition
4.1.3.3	Perform Beach to Surf Transition
4.2	Exit Wet/Dry Well (Self-Propelled)
4.2.1	Exit Wet Well (Self-Propelled)
4.2.2	Exit Dry Well (Self-Propelled)
4.3	Perform Station-Keeping
4.3.1	Perform Single Station-Keeping
4.3.2	Perform Formation Station-Keeping
4.4	Disengage from Ship
5.1	Perform Transition Over Hump
5.2	Change Course
5.2.1	Change Course Upwind
5.2.2	Change Course Downwind
5.2.3	Change Course Crosswind
5.3	Hold Craft on Track
5.4	Maintain Position in Formation Transit
5.5	Perform Mission-Dependent Tasks
5.6	Perform Underway Main Engine Water Wash
5.7	Perform Normal Stopping (Over Water)
5.8	Come Off-Cushion (Over Water)
5.9	Operate in Boating Mode
5.10	Come On-Cushion (Over Water)
6.1	Transit Water to Land
6.1.1	Perform Smooth Water Approach
6.1.2	Perform Surf Approach
6.2	Fly Up a Slope
6.3	Fly Across a Slope
6.4	Hold Craft on Track in Yaw Moment
6.5	Cross Obstacles
6.6	Perform Normal Stopping (Over Land)
6.7	Come Off-Cushion (Over Land)
6.7.1	Come Off-Cushion Level
6.7.2	Come Off-Cushion On Slope
7.1	Supervise Unload
7.2	Perform Lift-off and Hover Checklist Procedures
8.1	Transit From Land to Water

Figure 7. ACVOTS Training Device Task Listing

8.1.1	Obtain Clearance as Required
8.1.2	Maneuver Craft to Outbound Heading
8.1.3	Perform Land/Water Transition
8.1.3.1	Perform Beach to Smooth Water Transition
8.1.3.2	Perform Beach to Surf Transition
9.1	Perform Transition Over Hump
9.2	Change Course
9.2.1	Change Course Upwind
9.2.2	Change Course Downwind
9.2.3	Change Course Crosswind
9.3	Hold Craft on Track
9.4	Maintain Position in Formation Transit
9.5	Perform Mission-Dependent Tasks
9.6	Perform Underway Main Engine Water Wash
9.7	Perform Normal Stopping (Over Water)
9.8	Come Off-Cushion (Over Water)
9.9	Operate in Boating Mode
9.10	Come On-Cushion (Over Water)
10.1	Fly Up To Moving Ship
10.2	Moor To Ship
10.2.1	Moor To Ship Underway
10.2.2	Moor To Ship at Anchor (or Pier)
10.3	Refuel/Reload Craft
10.3.1	Perform Underway Refueling
10.3.2	Reload Craft (at Anchor)
10.4	Enter Well Deck (Self-Propelled)
10.5	Transit Water to Land
10.5.1	Perform Smooth Water Approach
10.5.2	Perform Surf Approach
11.1	Come Off-Cushion (Over Land)
11.2	Perform Craft Securing Checklist Procedures
11.2.1	Perform Equipment Shutdown Procedures
11.2.2	Perform Engine Shutdown Procedures
11.2.3	Perform APU Shutdown Procedures
11.3	Perform Refueling
11.4	Perform Mission Log Completion
13.1	Perform Emergency Stopping
13.1.1	Perform Emergency Stopping Over Land
13.1.2	Perform Emergency Stopping Over Water
13.2	Perform Fire Emergency Procedures
13.2.1	Perform Engine Fire Emergency Procedures
13.2.2	Perform APU Fire Emergency Procedures
13.2.3	Perform Craft Fire Emergency Procedures
13.2.4	Perform Deck/Cargo Fire Emergency Procedures
13.3	Recognize and React to Propulsion Power Loss Emergencies
13.3.1	Perform Single Engine Failure Emergency Procedures
13.3.2	Perform Multiple Engine Failure Emergency Procedures
13.3.3	Perform Transmission Failure Emergency Procedures
13.3.4	Perform N2 Govern Failure Emergency Procedures
13.3.5	Perform Fueling Failure Emergency Procedures
13.3.6	Perform Fuel System (Main Engines) Emergency Procedures

Figure 7. ACVOTS Training Device Task Listing (cont'd.)

13.3.7	Perform Fuel System (APU) Emergency Procedures
13.4	Recognize and React to Lift System Failure Emerg. Procedures
13.4.1	Perform Cushion Failure Emergency Procedures
13.4.2	Perform Keel/Lateral Stability Bags Loss Emerg. Procedures
13.4.3	Perform Loss of Lift Fan Emergency Procedures
13.5	Recognize and React to Degradation of Craft Control
13.5.1	Perform Control System Failure Emergency Procedures
13.5.2	Perform Propeller Failure Emergency Procedures
13.5.3	Perform Rudder Actuator Failure Emergency Procedures
13.5.4	Perform Bow Thruster Failure Emergency Procedures
13.5.5	Perform APU Failure Emergency Procedures
13.5.6	Perform Generator Failure Emergency Procedures
13.6	Perform Miscellaneous Emergency Procedures
13.6.1	Perform Flooding Emergency Procedures
13.6.2	Perform Man-Overboard Emergency Procedures
13.6.3	Perform Collision Emergency Procedures
13.6.6	Perform Plow-in Recovery
13.7	Perform Miscellaneous Abnormal Procedures
13.7.2	Perform Towing Operations
13.7.2.1	Perform Pre-Towing Checklist Procedures
13.7.2.2	Perform Towing Over Water (Set-Up)
13.7.2.3	Perform Towing Over Land (Set-Up)
13.7.3	Perform APU Protective Shutdown Procedures
13.7.4	Perform Main Engine Start Sequence Failure Procedures
14.1	Perform Buoy Operations
14.1.1	Perform Buoy Approach
14.1.2	Depart Buoy
14.1.3	Translate Side-to-Side Using Buoy as Reference

Figure 7. ACVOTS Training Device Task Listing (cont'd.)

included in the detailed operator task listing are those which did not satisfy the training device task selection criteria.

Annotation of Training Device Task Performance Cues. To objectively assess task training simulation requirements, cues preceding and during task performance must be understood on a task by task basis. This information was compiled with the assistance of JEFF(B) SMEs. Included were visual (including external, Field of View (FOV) and lighting), audio, and motion cues. In addition, cues were rated by the SMEs on being primary (critical to task performance) or secondary (present but not essential). Relevant data gathered in this step is present in the criterion objectives.

Gathering of Training Device Task Performance Conditions and Standards Data. Results of this step involved the organization of all task performance data for the 130 tasks and subtasks presented in Figure 7. Factors related to conditions included:

- Station characteristics - required cockpit presentation and situation,
- Environmental - variables influencing task performance,
- External - required external cues,
- Others - interaction with other crew members or external personnel,
- Information - paper documentation required,
- Initiating - station/craft situation prior to specific task performance,
- Completion - station/craft situation immediately following specific task completion, and,
- Interrelationships/Dependencies - other task performances prior to and following subject task performance and occurrence within the operational scenerio.

Factors relating to standards included:

- Controls used - inventory of all switches, knobs and controls used in subject task performance by operator and engineer,
- Instruments/Displays monitored - gages or other displays monitored during subject task performance, also by operator and engineer,

- Time/Speed - required or typical time performance of subject task,
- Accuracy/Error Rate - relates to sequence, degree and amount of control or display accuracy of response for subject task performance, and,
- Safety - considerations involved in subject task performance.

This information was used in the development of criterion objectives.

CANDIDATE TRAINING DEVICES. Since no ACV simulators are currently in production, generic categories of devices were defined. Six basic options were identified, covering the extent of control station simulation, degree of control fidelity and task performance cues. These options are:

- control station - Partial or Full
- station fidelity - functional or non-functional, and,
- cues - external or internal.

Identify ACVOTS Training Device Categories. All permutations of the above options were checked against existing device capabilities in training systems involving skills of similar or greater complexity. This check resulted in six categories of candidate training devices:

1. Partial Control Station - non-functional internal
2. Full Control Station - non-functional internal
3. Full Control Station - functional internal
4. Partial Control Station - functional internal and external
5. Full Control Station - functional internal and external
6. Full Control Station - functional internal and external (Navigator's station present)

Develop Working Definitions for Candidate Training Devices. Working (high level/non-engineering) definitions for these device categories were developed and are as follows:

- Cockpit (crew station) Familiarization Trainer (CFT). A facsimilie of the LCAC crew station used to facilitate learning the location of various controls, instruments, switches and lights in the cockpit and

practice and repetitive tasks such as use of checklists and performance of normal and abnormal/emergency operating procedures. The controls are not activated for response to operator inputs.

- Simple Part-Task Trainer (PTT1). A dynamic or non-dynamic device used to teach a task which is only a part of the overall task of operating the craft. A mock-up of the craft's fuel panel would be such a device.

- Cockpit (crew station) Procedures Trainer (CPT). A device used to provide operator and engineer training in normal and abnormal/emergency operating procedures. Craft instruments and other indicators respond to control inputs; exact dynamic simulation of all functions may or may not be required.

- Complex Part-Task Trainer (PTT2). A dynamic device incorporating craft operating characteristics used to teach closed-loop operating skills which are only part of the overall task of operating the craft. A limited, interactive cockpit representation used to teach beach penetration or plow-in avoidance would be such a device. Individual crew stations may be linked together.

- Operational Underway Trainer (OUT). An interactive operator and engineer training device which dynamically simulates the actual craft operating characteristics. Such devices are used to teach all operator underway tasks and include required cockpit external visual and motion cues.

- Full Mission Trainer (FMT). A device which allows simulation of all major tasks for all LCAC crew members (operator, engineer, navigator) for a given mission. It has the capability of simulating environmental conditions necessary for mission performance, including, but not limited to motion, visual systems, and dynamic vehicle characteristics . . . a fully dynamic system.

All of these candidate training devices were considered capable of meeting the long-term LCAC operator and engineer training requirements of the selected tasks. Only the FMT was considered to meet the LCAC navigator training requirements.

CRITERION OBJECTIVES. Using all previously organized data, 130 criterion objectives were developed. These objectives describe in detail the (1) conditions of task performance, i.e., what the student is provided, (2) statement of the task performance, and, (3) the standards of task performance, i.e., to what degree of proficiency the student must perform the task. These objectives will continue to be refined as the LCAC craft and mission scenario are

defined. The complete set of in-cabin, hands-on operator criterion objectives is presented in Volume II; Appendix A of this report.

TASK ASSIGNMENTS. Each task or subtask, where available, were assigned to one or more candidate training devices based on each device's constructed capability. Results of each of the sub-steps in this process are presented below.

Annotation of Training Device Deficiencies. The complete task listing including task procedural behaviors was analyzed against each of the six candidate devices. As indicated by the example in Figure 5, the results were a complete annotation of each device's capabilities, limitations and deficiencies for each of 946 discrete behaviors.

Calculate Task Completion Percentages and Hour Utilization Ratings for Candidate Training Devices. The percent of behaviors completed in each device for each subtask, or task where subtasks were not defined, was converted to a utilization (degree of capability) rating. In Figure 6, the set of rules governing this conversion is presented.

The assumption was made that percent of behaviors for a given task completed in a given device would indicate the training emphasis of that task in that device. This assumption and others are detailed later in the discussion of device assessment. The goal of this rating process was to provide a numerical means of determining the impact of individual devices and device mixes on actual craft operating time to complete training.

Develop Data Base For Final Task Sort. Tasks and rated device assignments were entered into a data base format for ease of sorting tasks to individual devices. In addition, task criticality, number of repetitions to achieve initial proficiency, number of repetitions to maintain proficiency, interaction with other personnel and minimum and maximum task performance times data for each task and subtask gathered from SMEs was entered as well. The data base format allows comparisons across devices for later device and device mix assessment. This data base is presented in Figure 8. Each line in that figure represents a single task or subtask and each column contains specific task

Task #	Task Statement	Criticality	# Repetitions to Achieve Proficiency	# Repetitions to Maintain Proficiency	Interaction: Engineer	Interaction: Navigator	Interaction: Deck Mech.	Interaction: Other	Min. Time to Per-form	Max. Time to Per-form	Device 1	Device 2	Device 3	Device 4	Device 5	Device 6
3.1	Perform Pre-mission Checklist Procedures	x	5	each mission	x	x	x	LH	3	7	CFT-2	PTT1-1	CPT-2		OUT-3	FMT-3
3.1.52	Perform Control Cabin Inspection	x	5	each mission					2	5		PTT1-1				
3.1.53	Direct Operating Crew Station Manning	x	2	2/year	x	x	x	LH	1	2	CFT-3		CPT-3		OUT-5	FMT-5
3.2	Start Craft	x	5	each mission	x		x	RM	6.25	11	CFT-3		CPT-4	PTT2-1	OUT-4	FMT-4
3.2.1	Perform Power-off Checklist Procedures	x	5	each mission	x				0.5	1.5	CFT-4		CPT-5		OUT-5	FMT-5
3.2.2	Perform APU Start Checklist Procedures	x	5	each mission	x				0.5	1.5	CFT-3		CPT-4		OUT-5	FMT-5
3.2.3	Perform Pre-start Checklist Procedures	x	5	each mission	x		x	RM	0.25	1	CFT-3		CPT-3	PTT2-1	OUT-4	FMT-4
3.2.4	Perform Main Engine(s) Start Checklist Procedures	x	5	each mission	x				5	7	CFT-3		CPT-3		OUT-5	FMT-5
3.3	Perform Pre-Underway Checklist Procedures	x	3	each mission	x	x	x		1	2	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
3.4	Perform Lift-off and Hover Checklist Procedures	x	20	each mission	x	x		RM	0.5	1	CFT-3		CPT-3	FTT2-3	OUT-4	FMT-4
4.1	Transit from Land to Water	x	10	2/month	x			RM	4.75	10	CFT-2		CPT-2	PTT2-3	OUT-3	FMT-3
4.1.1	Obtain Clearance as Required	x	5	2/month				RM	0.5	1	CFT-2		CPT-2	PTT2-2	OUT-5	FMT-5
4.1.2	Maneuver to Outbound Heading	x	10	2/month	x			RM	4	8	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
4.1.3	Perform Land to Water Transition	x	10	2/month	x				0.25	1	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
4.1.3.1	Perform Ramp or Slipway to Smooth Water Transition	x	5	2/month	x				0.25	0.5	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
4.1.3.2	Perform Beach to Smooth Water Transition	x	5	2/month	x				0.25	0.5	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
4.1.3.3	Perform Beach to Surf Transition	x	10	2/month	x				0.5	1	CFT-2		CPT-2	PTT2-3	OUT-3	FMT-3
4.2	Exit Wet/Dry Well (Self-Propelled)	x	4	Unknown	x			Ship LH	2	4	CFT-2		CPT-3	PTT2-3	OUT-4	FMT-4
4.2.1	Exit Wet Well (Self-Propelled)	x	4	Unknown	x			Ship LH	2	4	CFT-2		CPT-3	PTT2-3	OUT-4	FMT-4
4.2.2	Exit Dry Well (Self-Propelled)	x	4	Unknown	x			Ship LH	2	4	CFT-2		CPT-3	PTT2-3	OUT-4	FMT-4
4.3	Perform Station-Keeping	x	10	8/year		x		ACVs Opr	1	2	CFT-2		CPT-2	PTT2-3	OUT-5	FMT-5
4.3.1	Perform Single Station-Keeping	x	10	4/year		x			1	2	CFT-2		CPT-2	PTT2-3	OUT-5	FMT-5
4.3.2	Perform Formation Station-Keeping	x	10	4/year				ACVs Opr	1	2	CFT-2		CPT-2	PTT2-3	OUT-5	FMT-5
4.4	Disengage from Ship	x	3	1/year	x		x	Ship LH	2	3	CFT-1		CPT-1	PTT2-2	OUT-4	FMT-4
5.1	Perform Transition Over Hump	x	3	2/year	x	x			1.5	3	CFT-2		CPT-3	PTT2-3	OUT-4	FMT-4
5.2	Change Course	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
5.2.1	Change Course Upwind	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
5.2.2	Change Course Downwind	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
5.2.3	Change Course Crosswind	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
5.3	Hold Craft on Track	x	10	2/year		x			0.5	1			CPT-1	PTT2-2	OUT-4	FMT-5
5.4	Maintain Position in Formation Transit	x	2Adv	1/year		x		ACVs Opr	1	2				PTT2-1	OUT-5	FMT-5
5.5	Perform Mission-Dependent Tasks	x	....	....	.TBD		.	....	.....	..	CFT-1		CPT-1	PTT2-3	OUT-3	FMT-4
5.6	Perform Underway Main Engine Water Wash		2	1/year	x		x		12	15	CFT-2		CPT-2		OUT-4	FMT-4
5.7	Perform Normal Stopping (Over Water)	x	50	2/month	x				3	5	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
5.8	Come Off-Cushion (Over Water)	x	3	1/year	x				1	2	CFT-1		CPT-1	PTT2-1	OUT-4	FMT-4
5.9	Operate in Boating Mode	x	1	0		x			30	60	CFT-2		CPT-2	PTT2-3	OUT-3	FMT-4
5.10	Come On-Cushion (Over Water)	x	3	1/year	x	x			1.5	2	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
6.1	Transit Water to Land	x	12	1/month	x	x			5	10	CFT-1		CPT-1	PTT2-3	OUT-3	FMT-3
6.1.1	Perform Smooth Water Approach	x	3	2/year	x	x			5	10	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
6.1.2	Perform Surf Approach	x	12	1/month	x	x			5	10	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
6.2	Fly Up a Slope	x	10	2/year	x				2	4	CFT-3		CPT-3		OUT-4	FMT-4
6.3	Fly Across a Slope	x	20	2/year	x				0.5	1	CFT-1		CPT-1		OUT-4	FMT-4
6.4	Hold Craft on Track in Yaw Moment	x	5	2/year	x				0.5	1	CFT-1		CPT-1		OUT-3	FMT-3
6.5	Cross Obstacles	x	15	4/year	x	x			0.5	1	CFT-1		CPT-1		OUT-3	FMT-4

NONE — PARTIAL — FULL

0 1 2 3 4 5

Training Device Rating Scale

Figure 8. ACVOTS Task/Training Device Assignment Data Base

Task #	Task Statement	Criticality	# Repetitions to Achieve Proficiency	# Repetitions to Maintain Proficiency	Interaction: Engineer	Interaction: Navigator	Interaction: Deck Mech.	Interaction: Other	Min. Time to Perform	Max. Time to Perform	Device 1	Device 2	Device 3	Device 4	Device 5	Device 6
6.6	Perform Normal Stopping (Over Land)	x	75	5/month	x				3	5	CFT-1		CPT-1		OUT-4	FMT-4
6.7	Come Off-Cushion (Over Land)	x	6	4/year	x				1.5	2	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
6.7.1	Come Off-Cushion Level	x	4	4/year	x				1.5	2	CFT-1		CPT-1	PTT2-3	OUT-5	FMT-5
6.7.2	Come Off-Cushion On Slope	x	6	4/year	x				1.5	2	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
7.1	Supervise Unload	x	3	2/year	x		x	LH	30	60	CFT-1	PTT1-1	CPT-1		OUT-4	FMT-4
7.2	Perform Lift-off and Hover Checklist Procedures	x	5	2/year	x		x		1.5	2	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
8.1	Transit From Land to Water	x	10	2/month	x			BM	4.75	10	CFT-2		CPT-2	PTT2-3	OUT-3	FMT-3
8.1.1	Obtain Clearance as Required	x	5	2/month				BM	0.5	1	CFT-2		CPT-2	PTT2-2	OUT-5	FMT-5
8.1.2	Maneuver Craft to Outbound Heading	x	10	2/month	x			BM	4	8	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
8.1.3	Perform Land to Water Transition	x	10	2/month	x				0.25	1	CFT-3		CPT-3	PTT2-3	OUT-3	FMT-3
8.1.3.1	Perform Beach to Smooth Water Transition	x	5	2/month	x				0.25	0.5	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
8.1.3.2	Perform Beach to Surf Transition	x	10	2/month	x				0.5	1	CFT-2		CPT-2	PTT2-3	OUT-4	FMT-4
9.1	Perform Transition Over Hump	x	3	2/year	x	x			1.5	3	CFT-2		CPT-3	PTT2-3	OUT-4	FMT-4
9.2	Change Course	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
9.2.1	Change Course Upwind	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
9.2.2	Change Course Downwind	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
9.2.3	Change Course Crosswind	x	20	5/year	x	x			0.5	1	CFT-1		CPT-3	PTT2-3	OUT-4	FMT-4
9.3	Hold Craft on Track	x	10	2/year		x			0.5	1			CPT-1	PTT2-2	OUT-4	FMT-5
9.4	Maintain Position in Formation Transit	x	2Adv	1/year		x		ACVs Opr	1	2				PTT2-1	OUT-5	FMT-5
9.5	Perform Mission-Dependent Tasks	x	....	....	TBD		.	....	....	..	CFT-1		CPT-1	PTT2-3	OUT-3	FMT-4
9.6	Perform Underway Main Engine Water Wash		2	1/year	x		x		12	15	CFT-2		CPT-2		OUT-4	FMT-4
9.7	Perform Normal Stopping (Over Water)	x	50	2/month	x				3	5	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
9.8	Come Off-Cushion (Over Water)	x	3	1/year	x				1	2	CFT-1		CPT-1	PTT2-1	OUT-4	FMT-4
9.9	Operate in Boating Mode	x	1	0		x			30	60	CFT-2		CPT-2	PTT2-3	OUT-3	FMT-4
9.10	Come On-Cushion (Over Water)	x	3	1/year	x	x			1.5	2	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
10.1	Fly Up To Moving Ship	x	3	1/year	x	x			10	15	CFT-1		CPT-1		OUT-4	FMT-5
10.2	Moor To Ship	x	5	2/year	x	x	x	Ship PNL	15	20			CPT-1		OUT-4	FMT-4
10.2.1	Moor To Ship Underway	x	5	2/year	x	x	x	Ship PNL	15	20			CPT-1		OUT-4	FMT-4
10.2.2	Moor To Ship at Anchor (or Pier)	x	5	1/year	x			Ship PNL	15	20	CFT-1		CPT-1		OUT-4	FMT-4
10.3	Refuel/Reload Craft	x	5	2/year	x		x	Ship PNL	30	60	CFT-1	PTT1-2	CPT-3		OUT-4	FMT-4
10.3.1	Perform Underway Refueling	x	5	2/year	x		x	Ship PNL	30	60	CFT-1	PTT1-2	CPT-3		OUT-4	FMT-4
10.3.2	Reload Craft (at Anchor)	x	5	1/year	x		x	Ship PNL	30	60	CFT-1	PTT1-2	CPT-3		OUT-4	FMT-4
10.4	Enter Well Deck (Self-Propelled)	x	5	2/year	x			Ship LH	15	30	CFT-2		CPT-2	PTT2-3	OUT-4	FMT-4
10.5	Transit Water to Land	x	12	1/month	x	x			5	10	CFT-1		CPT-1	PTT2-3	OUT-3	FMT-3
10.5.1	Perform Smooth Water Approach	x	3	2/year	x	x			5	10	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
10.5.2	Perform Surf Approach	x	12	1/month	x	x			5	10	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
11.1	Come Off-Cushion (Over Land)	x	6	4/year	x				1.5	2	CFT-1		CPT-1	PTT2-3	OUT-5	FMT-5
11.2	Perform Craft Securing Checklist Procedures	x	5	each mission	x			Base	8	14	CFT-4		CPT-4		OUT-5	FMT-5
11.2.1	Perform Equipment Shutdown Procedures	x	5	each mission	x				3	6	CFT-4		CPT-4		OUT-5	FMT-5
11.2.2	Perform Engine Shutdown Procedures	x	5	each mission	x				3	6	CFT-3		CPT-4		OUT-5	FMT-5
11.2.3	Perform APU Shutdown Procedures	x	5	each mission	x				2	4	CFT-4		CPT-4		OUT-5	FMT-5
11.3	Perform Refueling	x	5	2/year	x		x	Base PNL	30	60	CFT-1		CPT-3		OUT-4	FMT-4
11.4	Perform Mission Log Completion		5	each mission	x	x	x	Base	5	10	CFT-3		CPT-5		OUT-5	FMT-5

NONE — PARTIAL — FULL

0 1 2 3 4 5

Training Device Rating Scale

Figure 8. ACVOTS Task/Training Device Assignment Data Base (cont'd)

Task #	Task Statement	Criticality	# Repetitions to Achieve Proficiency	# Repetitions to Maintain Proficiency	Interaction: Engineer	Interaction: Navigator	Interaction: Deck Mech.	Interaction: Other	Min. Time to Perform	Max. Time to Perform	Device 1	Device 2	Device 3	Device 4	Device 5	Device 6
13.1	Perform Emergency Stopping	x	5	verbal often	x	x			1.5	4	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
13.1.1	Perform Emergency Stopping Over Land	x	5	2/year	x	x			2	4	CFT-2		CPT-2	PTT2-3	OUT-4	FMT-4
13.1.2	Perform Emergency Stopping Over Water	x	5	2/year	x	x			1.5	3	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
13.2	Perform Fire Emergency Procedures	x	5	1/year	x	x	x	LH	1	2	CFT-2		CPT-2		OUT-4	FMT-4
13.2.1	Perform Engine Fire Emergency Procedures	x	5	1/year	x				1.5	2	CFT-2		CPT-2		OUT-4	FMT-4
13.2.2	Perform APU Fire Emergency Procedures	x	5	1/year	x				1.5	2	CFT-2		CPT-2		OUT-4	FMT-4
13.2.3	Perform Craft Fire Emergency Procedures	x	5	1/year	x				1	2	CFT-2		CPT-2		OUT-4	FMT-4
13.2.4	Perform Deck/Cargo Fire Emergency Procedures	x	2	1/year	x	x	x	LH	1.5	2	CFT-1		CPT-1		OUT-3	FMT-3
13.3	Recognize and React to Propulsion Power Loss Emergencies	x	7	7/year	x	x	x	LH	1	4	CFT-2	PTT1-1	CPT-2	PTT2-2	OUT-4	FMT-4
13.3.1	Perform Single Engine Failure Emergency Procedures	x	2	1/year	x	x			1	3	CFT-2		CPT-2	PTT2-2	OUT-4	FMT-4
13.3.2	Perform Multiple Engine Failure Emergency Procedures	x	2	1/year	x	x			1.5	3	CFT-2		CPT-2	PTT2-2	OUT-4	FMT-4
13.3.3	Perform Transmission Failure Emergency Procedures	x	1	1/year	x	x	x		2	4	CFT-2		CPT-2	PTT2-2	OUT-4	FMT-4
13.3.4	Perform N2 Govern Failure Emergency Procedures	x	1	1/year Academ	x				1	1.5	CFT-2		CPT-3	PTT2-3	OUT-5	FMT-5
13.3.5	Perform Fueling Failure Emergency Procedures	x	1	1/year Academ	x	x	x	LH	1	1.5	CFT-1		CPT-3		OUT-4	FMT-4
13.3.6	Perform Fuel System (Main Engines) Emergency Procedures	x	1	1/year Academ	x			Base	1.5	3	CFT-2	PTT1-1	CPT-2		OUT-4	FMT-4
13.3.7	Perform Fuel System (APU) Emergency Procedures	x	1	1/year	x		x		1.5	3	CFT-2		CPT-2		OUT-4	FMT-4
13.4	Recognize and React to Lift System Failure Emerg. Procedures	x	8	8/year	x		x	Base	2	4	CFT-2		CPT-2	PTT2-3	OUT-4	FMT-4
13.4.1	Perform Cushion Failure Emergency Procedures	x	3	1/year	x		x	Base	2	4	CFT-1		CPT-1	PTT2-2	OUT-4	FMT-4
13.4.2	Perform Keel/Lateral Stability Bags Loss Emerg. Procedures	x	2	1/year	x			Base	2	4	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
13.4.3	Perform Loss of Lift Fan Emergency Procedures	x	3	1/year	x		x	Base	2	4	CFT-2		CPT-3	PTT2-3	OUT-4	FMT-4
13.5	Recognize and React to Degradation of Craft Control	x	10	10/year	x	x		Base	1	5	CFT-2		CPT-2	PTT2-2	OUT-4	FMT-4
13.5.1	Perform Control System Failure Emergency Procedures		2	1/year Academ	x	x		Base	1	3	CFT-3		CPT-5		OUT-5	FMT-5
13.5.2	Perform Propeller Failure Emergency Procedures	x	1	1/year	x			Base	1	5	CFT-2		CPT-3	PTT2-3	OUT-4	FMT-4
13.5.3	Perform Rudder Actuator Failure Emergency Procedures		1	1/year Academ	x				1	3	CFT-1		CPT-1	PTT2-3	OUT-5	FMT-5
13.5.4	Perform Bow Thruster Failure Emergency Procedures	x	2	2/year	x				1	3	CFT-2		CPT-3	PTT2-2	OUT-3	FMT-3
13.5.5	Perform APU Failure Emergency Procedures	x	2	1/year	x	x		Base	2	4	CFT-2		CPT-3		OUT-4	FMT-4
13.5.6	Perform Generator Failure Emergency Procedures	x	2	1/year	x	x		Base	2	4	CFT-2		CPT-2		OUT-4	FMT-4
13.6	Perform Miscellaneous Emergency Procedures	x	13	Unk	x		x	Base	2	15	CFT-2		CPT-2	PTT2-3	OUT-3	FMT-3
13.6.1	Perform Flooding Emergency Procedures	x	1	Unk	x		x	Base	5	10	CFT-1		CPT-1	PTT2-2	OUT-3	FMT-3
13.6.2	Perform Man-Overboard Emergency Procedures	x	1	Unk	x		x	Base	5	15	CFT-1		CPT-1	PTT2-3	OUT-3	FMT-3
13.6.3	Perform Collision Emergency Procedures	x	1	Unk	x			COMM	5	60	CFT-1		CPT-1	PTT2-2	OUT-3	FMT-3
13.6.6	Perform Plow-in Recovery	x	10	2/year					2	5	CFT-2		CPT-2	PTT2-3	OUT-4	FMT-4
13.7	Perform Miscellaneous Abnormal Procedures	x	9	3/year	x		x	LH	5	40	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
13.7.2	Perform Towing Operations	x	2	1/year	x		x	LH	10	30	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
13.7.2.1	Perform Pre-Towing Checklist Procedures	x	2	1/year	x		x	LH	10	20	CFT-3		CPT-3	PTT2-3	OUT-4	FMT-4
13.7.2.2	Perform Towing Over Water	x	2	1/year	x		x	LH	15	30	CFT-1		CPT-1	PTT2-3	OUT-4	FMT-4
13.7.2.3	Perform Towing Over Land		2	Unk	x			COMM	15	30	CFT-1		CPT-1	PTT2-1	OUT-4	FMT-4
13.7.3	Perform APU Protective Shutdown Procedures	x	2	None			x		5	10	CFT-2		CPT-2		OUT-3	FMT-3
13.7.4	Perform Main Engine Start Sequence Failure Procedures	x	5	2/year	x		x		5	10	CFT-3		CPT-4		OUT-5	FMT-5
14.1	Perform Buoy Operations		2	1/year	x				30	45	CFT-2		CPT-2	PTT2-4	OUT-4	FMT-4
14.1.1	Perform Buoy Approach		2	1/year	x				10	15	CFT-2		CPT-2	PTT2-4	OUT-4	FMT-4
14.1.2	Depart Buoy		2	1/year	x				5	10	CFT-2		CPT-2	PTT2-4	OUT-4	FMT-4
14.1.3	Translate Side-to-Side Using Buoy as Reference		2	1/year	x				15	20	CFT-1		CPT-1	PTT2-4	OUT-4	FMT-4

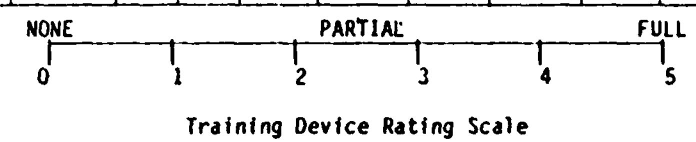

Figure 8. ACVOTS Task/Training Device Assignment Data Base (cont'd)

data as discussed above. An "x" in a column represents a "yes" or presence of individual interaction. "Other" annotations in the interaction column included:

RM	- ramp marshall,
LH	- craft line handler,
Ship LH	- amphibious support ship line handler(s),
ACVs Opr	- other ACV operators,
BM	- beach master (if available),
Ship PNL	- amphibious support personnel,
Base	- comm with base, and,
Comm	- open channel comm.

Conduct Final Task Sort. Sorting of tasks and sub-tasks to candidate devices was accomplished via word processor data base software. These task/device sorts were then assembled into the functional descriptions of each candidate device.

FUNCTIONAL DESCRIPTIONS. Supporting the assessment of candidate training devices against system training requirements is the development of functional descriptions. Elements of these functional descriptions include:

- Purpose of the device - summary of mission segments and objectives, and a description of the role of the device in the training system.
- Training objectives - a listing of the objectives which will be trained in the device.
- Device description - sufficient detail of the physical configuration and functional characteristics to enable reviewers, decision makers, training analysts, and SMEs to have a clear understanding of the capabilities of the device.
  - -- Trainee station configuration indicating the degree of realism and layout of controls and displays, motion and visual features, interaction capabilities, systems/subsystems to be simulated, and other as appropriate.

-- Performance parameters such as the limits and/or degraded modes of craft systems/subsystems to be simulated.

-- Instructor/operator control capabilities.

For those devices selected for procurement, the *functional* description will be the primary input into the development of detailed engineering characteristics. Functional descriptions for seven candidate LCAC training devices are presented in Volume II, Appendix C of this report. Two of these seven descriptions are part-task panel mockups.

ASSESSMENT OF CANDIDATE TRAINING DEVICES. Reductions in operational LCAC (actual craft) training time afforded by the use of the various training devices and device combinations can only be used as rough estimates. These estimates are supported by experience with simulators in similar applications. A number of additional assumptions were also made and are described below.

- The percentage of behavior completion in a given device for a given task is an indicator of the utilization of that device for training that task. The hypothesis is that the training emphasis rating described above, converted to a percentage of training (e.g., "3" converts to 60%), multiplied by the repetitions and time to perform, would provide a relatively "honest" measure of the given device's use in training the task. Summation of these times across all tasks or subtasks, where available, would then indicate the impact of a given device in the total syllabus.

- Hands-on training tasks were assigned to the lowest level device capable of partial or full accomplishment within any given mix.

- Only initial task proficiency was addressed. Inclusion of maintenance of skills or refresher training would only serve to improve the utilization of simulation and reduce costs/hour, whereas use of the craft involves a constant cost/hour.

- No provisions for attrition or re-performance of training missions due to poor performance was made in calculating craft utilization time. With a craft-only training system, this would entail considerably more expense.

- One hour of simulator time is equal to one hour of actual craft time. This is a conservative assumption based on the fact that training time is the issue. Actual transit time to the training site and set-up for task performance in the actual craft will result in higher operating costs per training hour than used in this assessment. More importantly, training strategies such as backward chaining (e.g., practicing stationary maneuvering before lift-off and hover), immediate repetition, immediate replay and stress shaping (e.g., introducing stronger

winds with successive repetitions) enrich simulator time and do not allow any direct comparison with actual craft underway training. Thus this simplification enabled the relative training impact of each device or device mix to be determined within the constraint of limited resources.

- Time spent on training part of a task in a lower-cost training device is assumed equal to time spent in a more expensive device training the whole task, when the time spent in each is considered behavior-by-behavior. This assumption is made even though each behavior might not be practiced in isolation in either device and is considered a simplification aimed at determining relative training impact offset by the benefit of stress shaping as described above. By subtracting common behaviors of a lower level device from those assigned to the next level device in a given mix and re-rating the latter on a task-by-task basis, a combined utilization was determined which is neither the sum of the two device utilizations individually, nor the simple difference between them.

- Transfer of learning from device to device and from device to actual craft must be maximized if actual craft time is to be minimized. The potential time required by a trainee to adjust previously learned behaviors in new environments involving more complex cues is not included in the assessment. This assumption can be justified if it is further assumed that those factors maximizing the transfer of learning will be incorporated into the long-term LCAC training system.

- It has been assumed that a task requiring an hour of training time in the LCAC will also require an hour when trained in a simulator. This assumption makes the comparison of mixes with each other, and comparison of craft time required by various mixes, a practical approach from the standpoint of the calculations involved. However, this assumption should not be accepted outside the framework of the present discussion. Experience with simulators shows clearly that a task requiring, for example, one hour to train without the simulator may be trained with the simulator in considerably <u>less</u> time.

- Craft time is also affected by simulator usage. If a task requires, for example, three hours to train in a craft, and if one hour is transferred to a simulator, the remaining two hours would logically seem to be unaffected, and thus two hours of training in the craft would be required. This is not always the case. Conceivably, the training in the simulator may shorten the time required to learn those tasks which can only be taught in the craft, so that, in our example, less than two hours need remain for instruction on the craft. The exact effect on task-learning time of a simulator can only be determined empirically, so that the assumption made here is appropriate to use at this stage of development.

While the above assumptions do not adversely affect the procedure or results of this analysis for the purposes originally defined, they do make

clear the need for further refinements. As is appropriate in the ISD process, iteration of the analyses as the program develops will be necessary.

Determine Total Training Hours for Candidate Training Devices. The first effort in assessing the candidate devices was estimation of each device's potential utility relative to the entire syllabus. The total task training time required for an individual based on SME-provided number of repetitions and time to perform each task was calculated as being 73.4 hours of craft time. The assumptions and methodology described above were applied to calculate maximum hours of training within the syllabus for each candidate device. A sample worksheet in this process is shown in Figure 9. The formula for calculating task device utilization is given by:

$$\text{Task/Device Utilization (Min)} = \frac{\text{Rating}}{5} \times (100\%) \times (\text{Repetitions}) \times (\text{Time to perform})$$

Based on this effort, hours for each device were:

CFT - 19.51 hours/student based on 293 ACVOTS operator behaviors

PTT1-A - (circuit breaker panel) - 0.83 hours/student based on 1 ACVOTS operator behavior

PTT1-B - (fuel management panel) - 4.01 hours/student based on 3 ACVOTS operator behaviors

CPT - 27.03 hours/student based on 422 ACVOTS operator behaviors

PTT2 - 21.11 hours/student based on 334 ACVOTS operator behaviors

OUT - 56.9 hours/student based on 843 ACVOTS operator behaviors

FMT - 57.6 hours/student based on 850 ACVOTS operator behaviors

Estimate Procurement and Operating Costs. Estimates of procurement and operating costs for each candidate device and the LCAC craft were developed from the above and are presented in Appendix E. All cost estimates are in 1982 dollars and do not include inflation or discounting. The device operating costs include amortized cost, electricity at $.075/kwh and maintenance technician time at $20 per hour where applicable, as well as instructor time at $30 per hour. Craft operating costs include amortized cost, spare parts, dedicated billets, overhaul at four years, organizational equipment and fuel

#	Task Statement	Device Rating	Repetitions to Achieve	Time to Perform (min.)	Training Time (min.)
3.1	Perform Pre-mission Checklist Procedures	CFT-2	5	7	--
3.1.53	Direct Operating Crew Station Manning	CFT-3	2	2	2.4
3.2	Start Craft	CFT-3	5	11	--
3.2.1	Perform Power-off Checklist Procedures	CFT-4	5	1.5	6
3.2.2	Perform APU Start Checklist Procedures	CFT-3	5	1.5	4.5
3.2.3	Perform Pre-start Checklist Procedures	CFT-3	5	1	3
3.2.4	Perform Main Engine(s) Start Checklist Procedures	CFT-3	5	7	21
3.3	Perform Pre-Underway Checklist Procedures	CFT-3	3	2	3.6
3.4	Perform Lift-off and Hover Checklist Procedures	CFT-3	20	1	12
4.1	Transit from Land to Water	CFT-2	10	10	--
4.1.1	Obtain Clearance as Required	CFT-2	5	1	2
4.1.2	Maneuver to Outbound Heading	CFT-1	10	8	16
4.1.3	Perform Land to Water Transition	CFT-3	10	1	--
4.1.3.1	Perform Ramp or Slipway to Smooth Water Transition	CFT-3	5	0.5	1.5
4.1.3.2	Perform Beach to Smooth Water Transition	CFT-3	5	0.5	1.5
4.1.3.3	Perform Beach to Surf Transition	CFT-2	10	1	4

Figure 9. Sample Device Utilization Worksheet

and periodic oil lubrication costs. These costs are based on 600 hours/year availability and are based on projected estimates for the LCAC[7].

Identify Candidate Training Device Mixes. All permutations of the seven candidate device mixes were assessed against a set of guidelines to arrive at a realistic set of training device mixes for analysis. These guidelines included:

- No mix contains both a CFT and a CPT because of the large measure of duplicity.
- For the same reason, no mix contains both an OUT and a FMT.
- All mixes have procedures practice capability.

The list of 16 candidate device mixes satisfying these guidelines is presented in Figure 11. All mixes were assessed against total craft utilization as well as remaining syllabus time allocated to the actual operating craft.

Since the PTT1-A and PTT1-B both involved low utilization and high cost per hour, it was decided to defer analysis of mixes containing these candidate devices until the most advantageous mixes utilizing other devices were determined. The impact of these devices was then addressed in the context of a smaller number of alternatives.

[7] Air Cushion Landing Craft Cost Models, SRI Report, NWRC, TN-80, July 1978.

A.	CFT				
B		CPT			
C.				OUT	
D.					FMT
E.	CFT			OUT	
F.	CFT				FMT
G.		CPT		OUT	
H.		CPT			FMT
I.	CFT		PTT2		
J.		CPT	PTT2		
K.			PTT2	OUT	
L.			PTT2		FMT
M.	CFT		PTT2	OUT	
N.	CFT		PTT2		FMT
O.		CPT	PTT2	OUT	
P.		CPT	PTT2		FMT

Figure 10. ACVOTS Training Device Mixes

Determine Total Training Hours and Costs for Candidate Training Device Mixes. The candidate mixes constructed in Figure 10 were then subjected to analysis aimed at obtaining relative training costs for both 12 trainees per year (1st year of system implementation) and 54 trainees per year (early 1990s). The rationale for testing device mixes with 54 trainees per year involves the following conditions:

- 108 craft in fleet,
- complete crew replacement every second year, and,
- single training device site.

The first mixes addressed were the single device/craft mixes of which there were four (A, B, C and D). Training cost estimates were calculated based on data in Appendix E, and using those estimates, total mix cost-to-train figures were obtained. The next level mixes (E, F, G and H) involved the combination of a low level procedures-type trainer (CFT or CPT) and a high level operational trainer (OUT or FMT). Based on the assumptions presented above, maximum utilization of the lower level trainer left a remainder of utilization on the higher level trainer with no greater impact on required

craft underway time than the high level operational trainers alone. Training cost estimates were then calculated as before.

The next level mixes (I and J) involved a low level procedures trainer (CFT or CPT) and the complex part-task trainer (PTT2). Here, maximum utilization of the lower level trainer was assumed. The time allocation for the PTT2 was obtained via a task-by-task behavior allocation as in the initial task annotation. All behaviors that could be performed in the lower level trainer were subtracted from those which could be performed in the PTT2. A new utility rating for the PTT2 for each task was then calculated in each of the two mixes. From this calculation a new total syllabus time allocation per student was determined. An example of the worksheet used in analysis of the CFT/PTT2 mix is presented in Figure 11. These two mixes generated a reduction in craft time more than with each device individually.

Similarly, in mixes K and L, all device-capable training was loaded into the PTT2 based on its original rating, and in a task-by-task behavior reallocation, new utility ratings for the OUT and FMT were determined. Total mix training costs were calculated as before. These two mixes generated a reduction in craft time more than the complex trainers alone.

The final group of candidate training device mixes (M, N, O and P) involved the lower level procedures trainers (CFT or CPT), the PTT2 and the higher level operational trainers (OUT or FMT). The analysis conducted for mixes I and J were applied behavior-by-behavior against the two operational trainers' capabilities in the annotated task listing, and new utilization ratings were determined for these two devices for each task within each of the four mixes. Thus, new total syllabi device allocation times per student were determined and training costs for each mix calculated.

In addition, mix cost calculations using 20 year amortization for all devices and the craft were run. No deviation in percent of total cost for any component (i.e., device(s) or craft) of any mix was found. Alteration of the amortization period served to reduce the <u>total</u> training cost of any one mix.

Finally, the two panel mock-up part-task trainers were added singly and in combination to Mix N to test the training and cost impact of their inclusion. These mock-ups reduce the utilization of the CFT since, as previously discussed, these panels' use in the higher level device (FMT in this case) was already moved to the CFT in the earlier analysis of Mix N. Results of this

#	Task Statement	CFT Rating	Original PTT2 Rating	New PTT2 Rating	# of Repetitions to Achieve Proficiency	Time to Perform Task (min.)	New PTT2 Time (min.)
3.3	Perform Pre-Underway Checklist Procedures	CFT-3	PTT2-3	PTT2-1	3	2	1.2
3.4	Perform Lift-off and Hover Checklist Procedures	CFT-3	PTT2-3	PTT2-2	20	1	8
4.1	Transit from Land to Water	--	--	--	10	10	--
4.1.1	Obtain Clearance as Required	CFT-2	PTT2-2	PTT2-0	5	1	0
4.1.2	Maneuver to Outbound Heading	CFT-1	PTT2-3	PTT2-2	10	8	32
4.1.3	Perform Land to Water Transition	--	--	--	10	1	--
4.1.3.1	Perform Ramp or Slipway to Smooth Water Transition	CFT-3	PTT2-3	PTT2-2	5	0.5	1.0
4.1.3.2	Perform Beach to Smooth Water Transition	CFT-3	PTT2-3	PTT2-2	5	0.5	1.0
4.1.3.3	Perform Beach to Surf Transition	CFT-2	PTT2-3	PTT2-2	10	1	4

Figure 11. Sample CFT/PTT2 Impact Analysis Worksheet

analysis are presented in Appendix E. Due to the minor training impact and relatively high utilization cost of these mock-ups with resultant higher net mix training cost, the analysis investigators eliminated them from further consideration.

While the craft utilization times in mixes M, N, O, and P may appear low, they are close to what may be accomplished. The analysis investigators believe an actual craft utilization time of 12-15 hours per student is realistically achievable. Furthermore, it is within the realm of projected maximum learning transfer typical of a totally integrated training approach.

Training and Cost Advantages and Disadvantages for Candidate Training Devices and Mixes. All data generated was used to construct individual device advantages and disadvantages within the projected syllabus. The following Tables 1 through 8, present the results of this assessment.

TABLE 1

Advantages and Disadvantages of the LCAC

Advantages	Disadvantages
- High transfer of training for normal tasks.	- High procurement and operating costs.
- Provides for full team training.	- Inability to train many abnormal and emergency conditions.
	- Rigid task training capability which prevents use of alternate learning strategies (e.g. backward chaining, playback, etc.)
	- Requires craft underway time to and from training site.
	- Weather/sea state dependent.

TABLE 2

Advantages and Disadvantages of the CFT
(shown in Volume II, Appendix D)

Advantages	Disadvantages
- Low procurement and operating costs.	- Only moderate utilization rate.
- Allows more efficient use of complex devices (OUT, FMT, LCAC).	- Inability to practice procedures in simulated high workload environment.
- Provides back-up capability for procedures practice if more complex devices not available.	- Feedback not provided by instrumentation operation in response to operator input.
- High availability for individual or team practice (operator/engineer) during on and off duty hours.	

TABLE 3

Advantages and Disadvantages of the PTT1-A
(shown in Volume II, Appendix D)

Advantages	Disadvantages
- Low procurement and operating costs.	- Low utilization rate.
- Portability/availability.	- Single task practice.

TABLE 4

Advantages and Disadvantages of the PTT1-B
(shown in Volume II, Appendix D)

Advantages	Disadvantages
- Low procurement and operating costs.	- Low utilization rate
- Portability/availability.	- Limited practice of only several tasks.
- Provides back-up capability for procedures practice if more complex devices not available CFT, CPT, etc.).	

TABLE 5

Advantages and Disadvantages of the CPT
(shown in Volume II, Appendix D)

Advantages	Disadvantages
- Low procurement and operating costs.	- Moderate utilization rate.
- Enables more efficient use of complex devices (OUT, FMT, LCAC).	- Limited ability to practice procedures in simulated high workload environments.
- Provides back-up capability for procedures practice if more complex devices (OUT, FMT, LCAC) are not available.	- Facilities impact.
- Available for refresher training and ACV Research and Development.	

TABLE 6

Advantages and Disadvantages of the PTT2
(shown in Volume II, Appendix D)

Advantages	Disadvantages
- Moderate procurement and operating costs.	- Moderate utilization rate.
- Allows more efficient use of complex devices (OUT, FMT, LCAC).	- No capability to integrate operating skills with total craft systems management skills in a simulated underway environment.
- Provides capability to concentrate on critical task performance and skills.	- Facilities impact.
- Available for refresher training and ACV Research and Development.	- Minor technology risk.
- Independent of weather/sea state visually.	

TABLE 7

Advantages and Disadvantages of the OUT
(shown in Volume II, Appendix D)

Advantages	Disadvantages
- Capability to integrate skills learned with underway skills in a simulated underway environment.	- High procurement cost.
- Significant reduction in underway LCAC required training time.	- Not full team training capable (No navigator position present).
- Moderate operating cost.	- Facilities impact.
- Available for refresher training and ACV Research and Development.	- Moderate technology risk.
- High utilization rate.	
- Emergency procedures practice.	
- Independent of weather/sea state.	

TABLE 8

Advantages and Disadvantages of the FMT
(shown in Volume II, Appendix D)

Advantages	Disadvantages
- Capable of training full-mission scenarios.	- High procurement cost.
- Moderate operating costs.	- Moderate technology risk.
- Significant reduction in required LCAC underway training time.	- Facilities impact.
- Less expensive than an OUT and navigator trainer combined.	
- Available for refresher training and ACV Research and Development.	
- High utilization rate.	
- Emergency procedures practice.	
- Independent of weather/sea state.	

Based on all analysis results, the analysis team determined that significant training and cost advantages existed in mixes M, N, O and P to warrant the exclusion of all others from further consideration. Training and cost advantages and disadvantages for these four training device mixes were developed employing all previous survey and analysis results. Results of this development are presented in Tables 9 through 12.

TABLE 9

Advantages and Disadvantages of the CPT, PTT2, FMT, LCAC MIX

Advantages	Disadvantages
- Lowest mix operating costs for training system life-cycle.	- Facilities impact for all devices.
- Significant reduction in required LCAC underway training time.	- Minor to moderate technology risk.
- Available for refresher training and ACV Research and Development.	- Requires craft underway time to and from training area.
- High training devices utilization.	
- Provides back-up training capability for procedures practice if more complex devices are not available.	
- High training transfer from training devices to the LCAC.	
- Provides simulation and craft full team training capability.	

TABLE 10

Advantages and Disadvantages of the CPT, PTT2, OUT, LCAC MIX

Advantages	Disadvantages
- Second lowest operating costs for training system life-cycle.	- Facilities impact for all devices.
- Significant reduction in required LCAC underway training time.	- Minor to moderate technology risk.
- Available for refresher training and ACV Research and Development.	- Requires craft underway time to and from training area.
- High training devices utilization.	- Does not provide full team training in simulation. Full team training only provided in the LCAC.
- Enables efficient use of the OUT and LCAC.	
- Provides back-up training capability for procedures practice if more complex devices are not available.	
- High training transfer from training devices to the LCAC.	

TABLE 11

Advantages and Disadvantages of the CFT, PTT2, FMT, LCAC MIX

Advantages	Disadvantages
- Third lowest operating costs for training system life-cycle.	- Facilities impact for PTT2, FMT, and LCAC.
- No facilities impact for CFT.	- Minor to moderate technology risk.
- Significant reduction in required LCAC underway training time.	- Requires craft underway time to and from training area.
- Available for refresher training and ACV Research and Development.	
- High training devices utilization to include low-cost self individual-team study in the CFT.	
- Enables efficient use of the FMT and LCAC.	
- Provides back-up training capability for procedures practice if more complex devices are not available.	
- High training transfer from training devices to the LCAC.	
- Provides simulation and craft full team training capability.	

TABLE 12

Advantages and Disadvantages of the CFT, PTT2, OUT, LCAC

Advantages	Disadvantages
- Fourth lowest operating costs for training system life-cycle.	- Facilities impact for PTT2, FMT, and LCAC.
- No facilities impact for CFT.	- Minor to moderate technology risk.
- Significant reduction in required LCAC underway training time.	- Requires craft underway time to and from training area.
- Available for refresher training and ACV Research and Development.	- Does not provide full team training in simulation. Full team training only provided in the LCAC.
- High training devices utilization to include low-cost self individual-team study in CFT.	
- Enables efficient use of the FMT and LCAC.	
- Provides back-up training capability for procedures practice if more complex devices are not available.	
- High training transfer from training devices to the LCAC.	
- Provides simulation and craft full team training capability.	

Discussion of the recommended and alternative training device mixes with supporting rationale is presented in the following section.

SECTION IV
RECOMMENDATIONS

OVERVIEW

The recommended and alternative ACVOTS training device mixes presented in this section for the long-term LCAC operator training program are based on the analysis guidelines (Section II) and results (Section III). Supporting rationale is also included for each recommendation.

RECOMMENDATIONS

One recommended training device mix and three alternative mixes are discussed in the following paragraphs. These mixes are:

Recommended -	CPT	Cockpit Procedures Trainer
	PTT2	Complex Part-task Trainer
	FMT	Full Mission Trainer
	LCAC	Landing Craft Air Cushion
Alternative 1 -	CFT	Cockpit Familiarization Trainer
	PTT2	Complex Part-task Trainer
	FMT	Full Mission Trainer
	LCAC	Landing Craft Air Cushion
Alternative 2 -	CPT	Cockpit Procedures Trainer
	PTT2	Complex Part-task Trainer
	OUT	Operational Underway Trainer
	LCAC	Landing Craft Air Cushion
Alternative 3 -	CFT	Cockpit Familiarization Trainer
	PTT2	Complex Part-task Trainer
	OUT	Operationat Underway Trainer
	LCAC	Landing Craft Air Cushion

RECOMMENDED TRAINING DEVICE MIX. The recommended training device mix (CPT, PTT2, FMT, and the LCAC) was selected because of its projection to be the most training- and cost-effective training device option for the long-term LCAC operator training program.

The mix provides the training to achieve the desired proficiency levels for the least cost for both the 12 and 54 student training options. This is achieved primarily through utilization of the least amount of LCAC underway training hours for any mix.

The minor to moderate technology risk (see Appendix B) associated with this mix in achieving or maintaining LCAC operator, engineer, and navigator task proficiency was not deemed significant enough to warrant degrading the training potential of this mix.

The facilities impact of this mix over other mixes without a CPT is greater. However, the facilities cost impacts will be offset by the amount of craft time reductions which can be achieved over other mixes, primarily from the availability of the CPT and/or PTT2 at the beginning of the Navy-run LCAC operator training program.

The increased capability of the CPT and PTT2 allow greater training flexability in areas of required additional or remedial operator and engineer training. Also, individual or team operator and engineer practice options can be made available with these type devices.

An additional benefit of this mix, which will become more evident as the operational concept and navigator's roles and responsibilities are further defined, is the capability to provide full team training with the FMT. Although a documented task analysis of the navigator's position has not been completed, the tasks in the operator's task listing, where navigator interaction occurred, were numerous enough to warrant full-team training consideration. It is also anticipated this requirement will become a prime training consideration as the LCAC and operational concept continue to evolve.

This recommended training device mix will contribute to maximum reduction of the three major constraints of the LCAC operator training program. This will occur due to the reduced LCAC underway training time required. The three major constraints are:

- high LCAC underway operating costs,
- potential noise abatement problems associated with LCAC underway operations, and
- potential safety problems associated with single seat control LCAC underway operations at high speeds in traffic congested areas of the proposed operational/training locations.

ALTERNATIVE TRAINING DEVICE MIXES. The three alternative mixes previously identified, are discussed below. The major differences between these alternatives include (1) the presence of a CPT or CFT, FMT or OUT, and (2) their cost

to train. All mixes will contribute to achieving desired proficiency levels for operators and engineers.

Alternative Mix #1 (CFT, PTT2, FMT and LCAC). The first alternative mix differs from the recommended mix by the substitution of a CFT for the CPT, and the time allocated for training in each device. This mix involves a larger amount of required LCAC underway training time and results in a higher net training cost.

This mix ranks as the third most cost-effective mix. However, the addition of the FMT (versus the OUT and CPT in the second most cost-effective mix) results in higher team training effectiveness. Considering training costs of the navigator, it is assumed this mix would be more total cost-effective than the second most cost-effective operator training mix. Therefore, the advantage of this mix over the alternative #2 mix largely results from the capability of the FMT versus the OUT.

The CFT in this mix has some advantages and disadvantages over the CPT proposed in the recommended and alternative #2 mixes. These advantages include:

- no facilities impact,
- low-cost self/team study,
- low-cost multiple trainer production capability, and
- placement in existing facilities at operational units.

Disadvantages include:

- limited training capability, thus higher useage and costs of more sophisticated training devices, and
- higher susceptability to damage of fragile components than other devices.

Alternative Mix #2 (CPT, PTT2, OUT, LCAC). The mix is the same as the recommended mix except for the replacement of the FMT with an OUT. The reduced capability of the OUT versus the FMT, results in more LCAC underway time. Therefore, the overall training system cost becomes higher than that of the recommended mix.

The difference in the capability of this mix (with an OUT and CPT) versus the mix with an FMT and a CFT (Alternative Mix #1) is the advantage of full-team training capability with the FMT. This advantage is important even though the operator training cost of this mix (#2) is less.

Alternative Mix #3 (CFT, PTT2, OUT and LCAC). This mix offered the fourth lowest procurement and operating costs due to the CFT versus CPT, and OUT versus FMT. The advantages of the CPT versus CFT, and FMT versus OUT were discussed in previous paragraphs. Therefore, the most significant factors in ranking this third alternative mix were the cost difference between it and the other mixes and the full-team training capability provided by those device suites which include a FMT.

TRAINING DEVICE SELECTION

Engineering specifications development must be initiated as soon as possible, followed by the beginning of the training device acquisition process.

This report clearly indicates that simulation is a viable training- and cost-effective approach to initial training of ACV operators, engineers, and navigators as well as maintaining their skill proficiencies after being initially qualified. Thus, use of simulation in the overall training program requires utmost consideration and progress in this area should be closely monitored.

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LIST OF ABBREVIATIONS

ACU	Assault Craft Unit
APU	Auxiliary Power Unit
BCN	beacon
BT	bow thruster
CFT	Cockpit Familiarization Trainer
CG	center of gravity
CGI	Computer Generated Imagery
CIG	Computer Image Generation
CPT	Cockpit Procedures Trainer
EGT	exhaust gas temperature
FMT	Full Mission Trainer
FOV	Field of View
GPM	gallons per minute
HF	high frequency
LCAC	Landing Craft, Air Cushion
M_{ct}	mean corrective maintenance downtime
MTBF	mean time between failure
NAV	navigation
OUT	Operational Underway Trainer
P	port
PTT1-A	Part Task Trainer 1 (mock-up) -A: the craft main circuit breaker panel
PTT1-B	Part Task Trainer 1 (mock-up) -B: the fuel management panel
PTT2	Part Task Trainer 2 (complex visual display)
R	rudder
S or Stbd	starboard
TBD	to be determined
UHF	ultra high frequency
VHF	very high frequency